THE IMPACT OF
SFAS NO. 2 AND THE ECONOMIC RECOVERY TAX ACT OF 1981
ON
FIRMS' R&D SPENDING BEHAVIOR

By

MOHAMED MARGHANY SHEHATA

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
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The objective of this study is to empirically examine the impact of two events on firms' incentives to invest in research and development (R&D): (1) the issuance of Statement of Financial Accounting Standards No. 2 (SFAS No. 2), promulgated in 1974, which has prompted much debate regarding its potential negative impact on firms' R&D activities, and (2) the enactment of the Economic Recovery Tax Act in 1981 (ERTA), which containes several provisions designed to stimulate firms' R&D activities.

The impact of SFAS No. 2 was examined both <u>ex-ante</u> using the two-stage switching regression analysis and <u>ex-post</u> using tests for structural changes. Employing these research methods required the

development of a model explaining the economic determinants of R&D investments (R&D model). In addition, the two-stage switching regression methodology required the development of a second model explaining the managerial choice of accounting method for reporting R&D costs (AC model).

The results of the *ex-ante* analysis indicate that the switching regression model predicted a significant potential reduction in capitalizers' R&D investments in response to SFAS No. 2. This finding is supported by the results obtained from the *ex-post* analysis which indicate significant structural changes in the R&D model in 1975 and 1976 and that the changes are manifest in the regression slopes rather than in the intercept. The results also indicate that the reduction in R&D diminished after 1976. The consistency of significant results in both the *ex-ante* and *ex-post* analyses suggests that the switching regression model is an appropriate research methodology for assessing, *ex-ante*, the likely economic consequences of proposed accounting changes. This line of research could, therefore, provide policy makers with valuable information for improving the standard setting process.

The effectiveness of the 1981 ERTA tax incentives in stimulating R&D investment is examined in a time-series cross-sectional framework using tests for structural changes. The results of the F test show significant structural changes in the R&D model after 1981, and that the changes are reflected in both the regression intercepts and slopes.

CHAPTER I

INTRODUCTION

1.1 Research Problem and Motivation

During the 1970s, there was widespread concern regarding sustained declines in industrial productivity and their adverse impact on the economic growth of individual firms and the economy. This decline in productivity was due, in part, to the decline in investment in research and development (R&D) activities. Nadiri and Bitros (1980) estimate that the reduced growth in R&D spending may account for as much as one-third of the productivity decline in the economy during the 1970s. In a similar vein, Scherer (1984) points out that if the 1960s real growth rate of R&D had been maintained during the 1970s U.S. companies would have undertaken approximately 40 percent more real R&D in 1980 than they actually did.

Recent accounting and economic research has attempted to explore some of the underlying reasons for the decline in R&D investments. Several accounting studies hypothesized that the observed decline in the level of R&D expenditures was partially due to the Statement of Financial Accounting Standards No. 2 (SFAS No. 2), promulgated in 1974, which required U.S. companies to expense R&D costs as incurred. For example, Elliott, Richardson, Dyckman, and Dukes (1984) report that many managers of capitalizing firms asserted that this change in accounting method necessitated reductions in their R&D spending. Similarly, Horwitz and Kolodny (1980) indicate that the majority of the companies in their survey claimed that they would increase R&D

expenditures if the deferral option were still available. However, as will be discussed later, previous empirical studies on the impact of SFAS No. 2 on firms' R&D expenditures have reported mixed results. These studies have been criticized both for their methodology and for failing to incorporate in their investigation the links between managers' R&D investment decisions and managers' choices of R&D accounting method. These shortcomings make it difficult to interpret the findings of previous studies and are likely to reduce the chances of detecting the impact of SFAS No. 2, if any, on firms' R&D spending behavior.

In an attempt to promote R&D spending, the Economic Recovery Tax Act of 1981 (ERTA) offered firms two significant tax incentives: (1) the R&D Tax Credit, which allows firms to deduct from their tax liabilities an amount equal to 25 percent of the increase of certain qualified R&D expenditures in excess of the average amount spent over the preceding three years, and (2) the Accelerated Cost Recovery System (ACRS), which provides special treatment in depreciating R&D equipment. During the last few years, a number of researchers have attempted to assess how firms have responded to these tax incentives. The preliminary results of this early research (using mainly survey data), as will be discussed below, have raised some doubts about the effectiveness of ERTA in stimulating industrial R&D expenditures.

Because of the shortcomings in the previous studies and the lack of consensus in their results, this study seeks further insights into the following two research questions: (1) did previous capitalizers reduce their R&D investments in response to SFAS No. 2 and (2) did the R&D tax incentives provided by the 1981 ERTA stimulate additional R&D investments?

1.1.1 The Impact of SFAS No. 2

It has been argued that the elimination of the deferral option might result in a reduction of R&D activity and therefore produce undesirable economic consequences. Several studies have addressed this issue using different methodologies. The results of these studies have been mixed and have not demonstrated a clear relationship between the implementation of SFAS No. 2 and changes in R&D investments. While Dukes and Dyckman (1980) found no significant impact of SFAS No. 2 on R&D in a sample of listed firms, Horwitz and Kolodny (1980) documented evidence of significant negative impact of SFAS No. 2 on R&D for a sample of OTC firms. In an attempt to reconcile the differences between the results of these two studies, Elliott et al. (1984) found significant relative declines in R&D expenditures for capitalizers among both listed and OTC firms. They suggest, however, that the observed decline in R&D may be attributed to changes in economic conditions rather than to the accounting change. This general statement is also consistent with the results reported by Vigeland (1981) who did not detect any abnormal security price effect associated with the issuance of SFAS No. 2.

In discussing the papers by Dukes et al. (1980) and Horowitz and Kolodny (1980), Ball (1980), Marshall (1980) and Wolfson (1980) point out three common weaknesses: (1) the use of an inappropriate research design (in particular, using the matched-pair technique), (2) the absence of a theory that explains firms' R&D investment decisions, and (3) the absence of a theory that explains managerial choice among accounting alternatives. These concerns are considered in the approach adopted in this study.

The first objective of this study is to examine the impact of SFAS No. 2 on firms' R&D investments using the two-stage switching

regression model. This research methodology is believed to be capable of correcting perceived deficiencies in prior research and improving the likelihood of detecting the impact of SFAS No. 2. The switching regression methodology requires the development of two models: One model explains firms' R&D investment decisions and the second model explains firms' choices of R&D accounting methods. Therefore, this research technique has the advantage of linking these two managerial decisions in an econometric model which overcomes some weaknesses of the previous research. In contrast to the methods used in prior studies, the switching regression methodology provides expectations of potential economic consequences of proposed changes in accounting standards prior to their adoption. This, in turn, improves the chances of detecting the impact of the accounting change, if there is any. The impact of SFAS No. 2, therefore, will be examined in view of those expectations.

1.1.2 Impact of ERTA

The second research question addressed in this study is whether firms' R&D investment decisions have been influenced favorably by the tax incentives introduced in the ERTA (i.e., the R&D tax credit and the ACRS).[1] The available empirical evidence suggests that the effectiveness of these tax incentives is questionable. For example, Eisner, Albert, and Sullivan (1984) and Mansfield (1986) report survey results suggesting that the tax credit has had little impact on R&D activity. Similarly, the 1985 NSF annual survey shows that only 30 percent of the surveyed companies reported that the availability of the tax credit had increased their R&D budgets (NSF, 1985). As with any survey study, the validity of these results must be interpreted cautiously.

The second objective of this study is to examine empirically the impact of ERTA on firms' R&D spending behavior. The R&D model developed in the first part of the study (in connection with SFAS No. 2) will be estimated for the periods before ERTA and then for the period after ERTA, usint OLS. The effect of the new regime will be reflected in the regression parameters. The impact of ERTA on firms' R&D spending behavior, therefore, will be examined using tests for structural changes in the R&D model.

1.2 Organization of the Study

The remainder of this thesis is organized as follows: Chapter II presents a review of the relevant literature. Chapter III presents the conceptual development of research hypotheses. Chapter IV develops the R&D investment model and the accounting choice model. Chapter V describes the research methodology and sample selection procedures. The empirical results and implication of the study are reported in Chapter VI. Chapter VII summarizes the research findings.

1.3 Note

1. The R&D tax credit allows firms to deduct from their tax liabilities up to 25 percent of their qualified R&D expenditures, in excess of the base-period amount. After 1982, the base is the average qualified expenses for the preceding three years. The base amount, however, can not be less than one-half of the R&D expenses for the tax year. Unused credits can be carried back three years and forward fifteen years. The credit was scheduled to expire at the end of 1985, but the Tax Reform Act of 1986 extended it for another three years and reduced the credit to 20 percent. The ACRS allows firms to depreciate their R&D equipment over three years regardless of the equipment's actual economic useful life. However, R&D equipment will qualify for only a 6 percent investment credit rather than 10 percent.

CHAPTER II

LITERATURE REVIEW

Four areas of research are relevant to the current study: (1) research examining the impact of SFAS No. 2 on firms' R&D spending behavior, (2) research examining the effectiveness of the R&D tax incentives, provided by ERTA, in stimulating firms' R&D investments, (3) research investigating the economic determinates of firms' R&D spending behavior, and (4) research investigating the economic determinants of firm choices of accounting methods. The literature related to the economic determinants of both the R&D and accounting choice decisions will be reviewed in Chapter IV. The literature related to the impact of SFAS No. 2 and ERTA on firms' R&D spending behavior is reviewed in this chapter.

2.1 SFAS No. 2 Studies

Prior empirical studies designed to investigate the economic consequences of SFAS No. 2 can be classified into three categories according to their approach: (1) studies designed to examine the direct impact of SFAS No. 2 on manager R&D investment decision [Dukes, Dyckman, and Elliott (1980), Horwitz and Kolodny (1980), and Elliott, Richardson, Dyckman, and Dukes (1984)], (2) studies designed to examine the impact of SFAS No. 2 on the behavior of capital market participants [Vigeland (1981)], and (3) studies which used survey questionnaires to assess managers' perceptions and attitudes toward

the implementation of SFAS No. 2 [Horwitz and Kolodny (1980) and Selto and Clause (1985)].

The studies which followed the first approach, using primarily the matched-pair research methodology, reported conflicting results as to whether firms' R&D investments are affected by the accounting change. Dukes et al. (1980) investigate whether SFAS No. 2 has induced managers to alter their R&D investment decisions. The study employs three sets of tests on a sample of 27 pairs of large expensing and capitalizing firms; (1) tests based on a matched-firm sample, (2) tests based on an unmatched-firm sample, and (3) a logit prediction model test. The statistical tests involve a comparison of the change in the ratio of R&D to sales from the pre-SFAS No. 2 period to the post-SFAS No. 2 period between capitalizing and expensing firms. All three tests fail to reject the null hypothesis of no effect of SFAS No. 2 on firms' R&D expenditures. The authors claim that the support for their conclusion lies essentially in the matched-pair tests. However, in his comments on Dukes et al., Ball (1980) points out that the major weakness of their study is the use of the pair matching research technique. In their conclusion, the authors point out the fact that sampling from larger firms limits generalizability of the results.

Horwitz and Kolodny (1980) also employ a matched-pairs research design on a sample of 43 pairs of small firms. The Wilcoxon Matched-Pairs Signed-Ranks test was used to examine the effect of the change in two ways; (1) comparing the mean of R&D expenditures of the three-year period prior to SFAS No. 2 with the mean of R&D expenditures for the period after SFAS No. 2, and (2) comparing the observed changes in R&D expenditures of capitalizing firms around the adoption of SFAS No.

2 to changes in R&D expenditures of expensing firms. In contrast to the results reported by Dukes et al. (1980), Horwitz and Kolodny found significant association between the implementation of SFAS No. 2 and the decline of capitalizers' R&D expenditures.

Elliott et al. (1984) extended these two studies using augmented samples of capitalizing firms and a different sample of control firms. Employing an averaging methodology similar to that used by Horwitz and Kolodny, the study found significant relative declines in R&D expenditures among both large and small firms. However, the authors claim that they were unable to resolve the question of whether the issuance of SFAS No. 2 had an important effect on R&D expenditures.

As explained earlier, the common weaknesses of these studies are (1) the use of an inappropriate research design (in particular, using the matched pairs technique), (2) the absence of a theory that explains firms' R&D investment decisions, and (3) the absence of a theory that explains the managerial choice of accounting methods [Ball (1980), Marshall (1980), and Wolfson (1980)]. A problem with the matched-pairs research methodology is that it assumes that each pair in the sample (from both experimental and control firms) is identical in all respects except for the treatment (i.e. R&D accounting method used). Wolfson (1980) argues that the phrases "identical in all respects" and "except for R&D accounting method chosen" are mutually inconsistent if one adopts the perspective that the accounting methods and production, investment, and financing decisions are interdependent. Indeed, the matched-pairs research design, does not account for these differences.

The second group of studies investigates the impact of SFAS No. 2 on stock price movements during the period surrounding the issuance of

SFAS No. 2, assuming the market is efficient in the semi-strong form. Vigeland (1981) examines the market reaction to the introduction of SFAS No. 2. The methodology employed in this study involves a comparison in the period surrounding the release of SFAS No. 2 of the returns on stocks of an experimental sample with the returns on stocks of a control sample. The study examines the stock market reaction surrounding four critical event dates; the date of the release of the discussion memorandum, the date of the release of the exposure draft, the date of the issuance of the statement, and the effective date of the statement. The test results show no significant market reaction to SFAS No. 2. Vigeland points out that the non-random sample selection procedures preclude generalizing the results beyond his sample, and recommends replication of the study on a different sample to validate his results. A potential problem with Vigeland's study (as well as with market-based studies in general) which may confound the results is the lack of direct connection between market model disturbances and the effect of the mandated accounting change.[1]

The third approach used by previous studies to examine the impact of SFAS No. 2 on firms' R&D spending behavior uses questionnaire-generated data. Horwitz and Kolodny (1980) report results of a questionnaire distributed to chief financial officers of 380 OTC companies which asked them their perceptions and attitudes toward SFAS No. 2. The response rate to the questionnaire was 34 percent. Responses were classified by deferral and expense firms to test the hypothesis that the responses from the two groups were significantly different. The overall results indicate that managers of both capitalizing and expensing firms believe that R&D outlay would possibly be greater if the deferral option was still available.

Selto and Clause (1985) investigate the extent to which capitalizers adapted their internal evaluation and compensation schemes in response to SFAS No. 2 using a survey questionnaire sent to 70 capitalizing firms. Their results indicate that seven firms did adapt (for example by continuing to defer R&D internally) and nine firms did not adapt. The authors test for differences in mean R&D spending across groups using a regression model of R&D as a linear function of lagged R&D and net sales. Their results indicate that firms which did not adapt had relatively lower R&D expenditures than either adapted or control firms.

Questionnaires present several potential limitations: non-response bias, subjectivity of responses, difficulty of quantifying the effects of the event, concerns about the sensitivity of responses to the position, mode, experience, etc., of the person to whom the questionnaire is addressed, interpretation of the responses, and concerns about whether the sample is representative of the population. Therefore, results obtained from studies using this approach should be interpreted with caution.

2.2 ERTA Studies

The literature contains few studies which attempt to assess the impact of R&D tax incentives provided by 1981 ERTA. These studies can be divided into two categories. The first category includes studies which attempt to identify and analyze the impact of various tax incentives [Barth, Cordes, and Tassey (1984) and Eisner, Albert, and Sullivan (1984)]. The second group consists of studies that attempt to examine empirically the impact of R&D tax incentives on managers' decisions to invest in R&D [Eisner et al. (1984), Porcano (1984),

Mansfield (1986) and Crowell (1987)]. These studies used mainly questionnaire data to examine the perceived importance of certain features of ERTA R&D tax incentives by corporate executives but without examining the reaction to these incentives in terms of actual R&D data. Barth et al. (1984), as will be discussed in the next chapter, used an analytical approach based on the cost-of-capital formula to quantify the impact of the R&D tax credit and ACRS on managers' incentives to invest in R&D activity.

The study by Eisner et al. (1984) consists of two parts. In the first part the conceptual framework was developed to analyze the effectiveness of R&D tax credits in stimulating additional R&D expenditures. Their analysis suggests that the effectiveness of the credit is hard to detect because the credit is tied, in part, to increases in R&D expenditures, irrespective of the reason for change and because the effective rate of the credit is small. The authors provide calculations showing that the effective rate of the R&D tax is only 4 to 6 percent, depending on the firm's discount rate, even when the credit is fully used. This part of their study concludes that, because of the incremental feature of the credit, its effectiveness in stimulating additional R&D is greatly reduced.

In the second part of the study, Eisner et al. attempt to empirically test the effectiveness of the R&D tax credit using actual data. R&D tax credit data were gathered from tax return information provided by the office of tax analysis for 1981. Additionally, the 1980-1982 R&D expenditures were obtained from compustat tapes. The tests involve comparison of R&D expenditures by firms in a position to utilize the credit with those firms not in a position to benefit from

the credit. Their results suggest the absence of evidence supporting the effectiveness of the tax incentives.

Using R&D McGraw-Hill survey data (which give more detailed information about R&D, qualified R&D, and the R&D tax credit) the authors conducted further analysis to test the effectiveness of the tax credit. They examined whether qualified R&D grew significantly faster than non-qualified R&D. Their results indicate that in 1981 qualified R&D increased by 21.3 percent of lagged total R&D, while non-qualified R&D fell by 4.4 percent of lagged total R&D. The 1982 figures were an 8.6 percent increase for qualified R&D and a 2.1 percent decline for non-qualified R&D. The differences between R&D in both years are statistically significant which may indicate that some firms made substitution in response to the credit.

Mansfield (1986) examined the impact of R&D tax credits on firms' R&D activities for three samples of firms from the U.S., Canada and Sweden using survey data. The samples included about 30 percent of all company financed R&D in the U.S. and Canada and about 80 percent of all company financed R&D in Sweden. For each firm, an estimate was obtained of the effect of the relevant R&D tax incentive on R&D spending as estimated by firms' top executives. The results indicate that the U.S. R&D tax credit and the direct R&D tax incentives in Canada and Sweden have increased industrial R&D by only about 1 or 2 percent, which amounts to about one-third of the foregone government revenues.

Finally, Crowell (1987) develops an econometric model that combines time-series and cross-sectional data to statistically measure the impact of various economic and financial variables, including the R&D tax credits, on the aggregate national level of R&D spending. The

time series component of the data consists of data extending from the pre-credit years (1961-1980) to the post-credit years (1981-1983). The cross-sectional data consist of 15 individual industries classified at the two-digit SIC level. The results of statistical tests suggest that the R&D tax credit had significantly influenced the aggregate national level of corporate R&D expenditures.

All previous studies (except Crowell) used questionnaire data to examine the effectiveness of the R&D tax credits. As indicated earlier, using survey data has its own inherent limitations. Oosterhuis (1984) argues that many corporate financial executives are institutionally oriented into denying that a tax incentive has affected their budgeting decisions. In contrast, R&D managers will probably give different responses. The findings of these studies should be interpreted with caution. In addition, Oosterhuis (1984) raises a concern about the time period used by most studies to examine the impact of the tax credit (1981 and 1982). He argues that it is too early to tell whether the credit has actually increased R&D activity because the credit was enacted in August 1981 and was not likely to be taken into account in planning until sometime in 1982. The effect of the incentive, therefore, is likely to affect the 1983 decisions.

2.3 Summary

In this chapter I reviewed prior research related to the two research questions addressed in this study. Section 2.1 contains a review of the literature of economic consequences of SFAS No. 2. The discussion indicated that three different approaches were used by previous studies in examining the impact of SFAS No. 2: (1) direct examination of the impact of SFAS No. 2 on firm's R&D spending, (2)

examining the market reaction to the issuance of SFAS No. 2, and (3) using survey data. Some major weaknesses associated with these approaches were discussed. In section 2.2, I discussed the literature related to the impact of R&D tax incentives on firms' R&D expenditures. The literature in this area contains very few studies which are mostly based on survey data. The shortcomings of the literature reviewed in this chapter provide the impetus for the two research questions addressed in this study.

2.4 Note

1. Foster (1980) provides a general critique of market-based studies which attempts to assess the economic consequences of accounting policy changes. See also Ball (1980) and Dhaliwal (1984) for more discussion on potential problems associated with this line of research.

CHAPTER III

DEVELOPMENT OF RESEARCH HYPOTHESES

This chapter develops the hypotheses to be empirically examined in this study. Section 3.1 develops the hypothesis regarding the impact of SFAS No. 2 on firms' R&D spending behavior and section 3.2 develops the hypothesis related to the impact of the 1981 R&D tax incentives on firms' R&D spending behavior.

3.1 The Impact of SFAS No. 2

Over the past several years, research has focused on understanding managerial choices among available accounting methods and their connection with economic decisions (i.e., production, investment, and financing decisions). Many researchers view the choice of accounting methods as being embedded in the overall decision making process under uncertainty which itself is guided by a wealth-maximization objective [see, e.g., Ijiri, Jaedicke, and Knight (1966), Demski (1973), Gonedes (1979), Collins, Rozeff, and Dhaliwal (1981), and Dhaliwal (1984)]. Ijiri et al. (1966) have shown that management decisions are affected by alteration or selection of accounting methods. Gonedes (1979) uses inventory costing to develop a conceptual framework showing the connection between the effects of accounting techniques on corporate equilibrium values and the substantive attributes of firms' economic decisions. His results indicate that the optimal inventory method is inextricably bound by the characteristics of a firm's production and investment decisions

and that the method selected affects a firm's current equilibrium value. Collins et al. (1981) view the choice of accounting method as part of the overall choice problem of wealth-maximization. Kelly (1983) assumes that, at any given time, the firm possesses an optimal mix of accounting procedures to maximize its wealth. Dhaliwal (1984) argues that firms select accounting methods within the context of the economics of choice under uncertainty, and that the particular methods selected are systematically related to certain characteristics of the firm.

The above discussion indicates that the managerial choices of accounting methods and economic decisions are interrelated, and that both decisions are guided by the overall objective of the firm. Hence, it can be argued that given the available set of production, investment, and financing opportunities, as well as the available accounting alternatives, managers select the optimal mix of accounting procedures that fits their production, investment, and financing decisions. Changes in one or more of these constraints is expected to affect the optimal value of the firm. This will shift the firm to a new equilibrium position.

SFAS No. 2 eliminates the capitalization method, which alters the chosen mix of accounting methods for the given managerial decisions. Consequently, it can be argued that management will seek to balance the mix of policy choices by altering the investment in R&D. This is likely to be in response to the change in the equilibrium value of the firm. This argument closely parallels Wolfson's (1980) who asserts that ". . . being required to change accounting methods could certainly move a firm to a new equilibrium position" (p. 75). Wolfson goes further to claim that if general rather than partial equilibrium

effects are considered, then even firms that are not forced to change accounting methods may also move to new equilibrium positions.

A necessary condition for the above scenario to hold is the existence of interdependency between accounting choice and decisions about the level of R&D costs. Evidence supporting the assumed interdependency between economic decisions and accounting method choices is reported by numerous studies. For example, Dhaliwal (1980) found that highly levered firms avoid accounting methods that result in lower and/or more volatile accounting earnings. Zmijewski and Hagerman (1981) report evidence suggesting that firms choose accounting methods pursuant to an income strategy decision process.

Agency theory and the income smoothing paradigm are used in suggesting linkage between the R&D accounting method and R&D investment decision, and in explaining why eliminating the capitalization method may induce managers to alter their R&D investment decisions.

3.1.1 Agency Theory

Agency theory views the firm as a set of contractual agreements among the suppliers of various factors of production [Alchian and Demsetz (1972), Jensen and Meckling (1976), and Fama (1980)]. Motivated by self-interest, each party may take action to maximize its own wealth at the expense of other parties. In order to mitigate such actions and reduce the conflict of interests among the different claimholders, agency theory suggests that contracts (e.g., bond covenants and management compensation contracts) should be designed so as to align the interests of different parties and reduce the incentive to transfer wealth from one group to another. For example, debt covenants reduce the likelihood of managerial actions that result

in transfering wealth from debtholders to shareholders (such as materially increasing leverage while keeping minimum working capital). Similarly, management compensation contracts are frequently tied to reported accounting earnings so that managers cannot benefit at the expense of shareholders. Changes in GAAP might affect the indentures of these contracts which would have potential impact on the firm value and its distribution among claimholders.

In this study, the implementation of SFAS No. 2 is expected to have the following effects. First, expensing all R&D costs as incurred will result in lower accounting earnings, particularly for growing firms and firms with growing R&D investments. This, in turn, may increase the volatility of reported earnings. Second, SFAS No. 2 required firms to write-off all previously capitalized R&D against retained earnings in the year of the switch. That likely resulted in a sharp reduction of retained earnings and a higher debt-to-equity ratio leading the firm to move closer to debt covenants' constraints. The greater likelihood of technical default might accelerate the maturation of the debt or a costly renegotiation of indentures. Furthermore, the new indenture would typically prohibit issuance of more debt or impose more restrictions on the investment in risky projects. It is likely that the new indenture agreement would restrict investments in high risk projects including R&D. Thus, optimal capital structure, investment opportunities (particularly in R&D activities) and the value of the firm are likely to be affected by the elimination of the capitalization method.

A similar argument can be made with respect to management compensation contracts. Management's wealth, which is typically tied to stockholders' wealth, would also be affected through reductions in the base of computing bonuses, stock ownership and/or human capital.

Therefore, utility-maximizing managers would be expected to alter their decisions so as to mitigate any potential adverse impact of SFAS No. 2 on their wealth.

Firms, however, can maintain the effectiveness of these contracts by renegotiating them to mitigate any negative effects. For example, rational owners should anticipate the potential of any adverse impact of SFAS No. 2 (on management's wealth) and adjust managerial compensation contracts to avoid dysfunctional effects (Selto and Clouse, 1985).

In summary, agency theory suggests that SFAS No. 2 could reduce the value of the firm and may result in transfering more wealth from shareholders to debt holders as investment in risky projects like R&D declines and as renegotiation costs rise for common shareholders.

3.1.2 The Income Smoothing Paradigm

The income smoothing hypothesis postulates that managers prefer to reduce fluctuations in earnings and report a steady (increasing) stream of income in order to please stockholders. This can be accomplished in several ways including discretionary accounting policy decisions and management discretionary expenditures. Gordon (1964), for example, hypothesizes that managers maximize their utility, which is dependent on stockholders' satisfaction with their performance, by selecting accounting methods that smooth the rate of growth of reported earnings. Although empirical evidence related to the smoothing hypothesis is somewhat mixed, the weight of the evidence appears to support the hypothesis. In summarizing this evidence, Ronen and Sadan (1981, p. 36) concluded that "by and large, the studies detected the existence of smoothing behavior, but most suffered from methodological problems."

Under the capitalization method, costs of R&D activity are carried as assets and allocated over several years. R&D costs, therefore, are matched against future earnings which presumably will be generated partially by the return from the R&D investment. Smoothing would reduce the effect of R&D outlays on current earnings and would possibly reduce the volatility of reported earnings. Managerial interest in the capitalization option, therefore, lies in the inherent flexibility in managing the reported annual earnings. By eliminating the capitalization method, SFAS No. 2 restricts their ability to control earnings variations through accounting procedures. The income smoothing hypothesis, therefore, predicts that managers may attempt to reduce fluctuations in net income by altering the discretionary component of R&D investment decisions. Evidence provided by Dascher and Malcolm (1970) and Beidleman (1973) is consistent with this prediction. Hufbauer (1981) extends the argument contending that immediate expensing of all R&D costs leads firms to ignore their long term economic value and underinvest in R&D activity in order to smooth earnings per share in bad years.

In summary, both agency theory and the income smoothing paradigm suggest that the managerial choice of accounting method and the R&D investment decision are interdependent and that the elimination of the capitalization method is likely to reduce R&D investments. Thus, the following hypothesis is proposed:

Ho: Capitalizing firms are not expected to reduce their R&D expenditures due to the intervention of SFAS No. 2

Ha: Capitalizing firms are expected to reduce their R&D expenditures due to the intervention of SFAS No. 2

3.2 The Impact of ERTA

The Economic Recovery Tax Act of 1981 (ERTA) has provided firms with a number of significant tax incentives to stimulate their R&D activities. The most important of these are the R&D tax credit and ACRS.[1] These tax incentives can influence R&D spending in at least two ways. First, they are designed to reduce tax liabilities and, thus, increase net cash flow. Part of the increase in cash flow is expected to be used to fund more R&D projects. Second, tax savings from R&D investments reduce the real cost of conducting R&D activities. This, in turn, makes R&D projects relatively more attractive in comparison to other competing investments in the firm; a condition that is expected to lead firms to allocate a larger portion of their budgets to R&D activities. These two effects could allow marginal R&D projects to meet the neccessary threshold. These tax incentives, therefore, are expected to stimulate additional R&D.

Due to certain features of the R&D tax credit and ACRS, doubts have been raised about their effectiveness in stimulating firms' R&D investments. Furthermore, previous research has produced contradictory results regarding the perceived effectiveness of these tax incentives. The following discussion begins by analyzing the impact of each of the two tax incentives on firms' R&D decisions separately. The combined impact of ACRS and the R&D tax credit will then be discussed.

3.2.1 The Impact of the R&D Tax Credit

Section 221 of ERTA (which became Section 44F of the IRC) allows firms to claim a nonrefundable tax credit of an amount equal to 25

percent of their qualified R&D expenditures in excess of a base-period amount. The base is the average qualified expenditures for the three years preceding the relevant tax year. The base amount, however, cannot be less than one-half of the R&D expenditures for the tax year. Unused credits can be carried back three years or forward fifteen years.

The objectives of the credit are to reduce business taxes, increase cash flow, and reduce the actual cost of conducting R&D. For example, at one extreme, an extra dollar spent above the base amount on qualified R&D expenditures, for a company which is able to utilize the full tax credit, would actually cost the company only 29 cents (assuming 46 percent tax rate). Taken by itself, this is a significant reduction in the real cost of conducting R&D which should provide a strong incentive for taking on new R&D projects. However, because of the incremental feature of the credit, the effective tax credit is much less than its 25 percent face value which is likely to reduce its effectiveness. A one dollar increase in R&D in the current period will increase the base amount by 33 cents in each of the succeeding three years. Eisner et al. (1984) show that the effective tax credit rate is only about 4.3 percent. This feature of the credit indicates that it may not provide sufficient incentives for firms to successively increase their R&D expenditures over time. However, it can be argued that the rationale of the incremental feature of the credit is to relate the credit more closely to increases in R&D on an on-going basis. Thus, if a company wants to maintain a certain amount of credit, it has to increase its R&D expenditure progressively.

The effectiveness of the tax credit may also be reduced because it is temporary. Zschau (1984) argues that the temporary feature of the credit created an uncertainty that made it less effective than it might otherwise have been for motivating investment in longer-term, riskier projects.

Using the Cost-of-Capital approach, Barth, Cordes, and Tassey (1984) develop an analytical framework to analyze and quantify the impact of the R&D tax incentive and ACRS on the firm's decision to invest in R&D. They have shown analytically how each of these tax incentives has affected the hurdle rate of return that R&D investments must earn when compared with other competing investment activities. Barth et al. point out that analyzing the impact of the tax credit on firms' incentives to invest in R&D activities by using the Cost-of-Capital approach is complicated by the fact that the credit is incremental and temporary. Therefore, they began by modelling the impact of a permanent nonincremental tax credit. Then, they extended the analysis by including the incremental feature. They concluded with consideration of the temporary feature of the credit. Their analysis of a nonincremental permanent tax credit has shown that such a credit would positively influence R&D investments in two ways. First, it reduces the required rate of return which encourages firms to substitute investment in R&D for other investments. Second, by subsidizing one of the firm's imputs, such a credit would have a wealth effect that encourages the firm to increase their purchase of all capital imputs, including R&D. These two effects, therefore, are expected to significantly influence R&D activity.

When Barth et al. considered the temporary feature of the credit, their analysis showed that a temporary tax credit would result in a greater increase in total R&D spending during the allowance period than would a permanent tax credit. However, this impact would be offset by the fact that a temporary tax credit has a smaller wealth effect than does a permanent credit. Thus, depending on the strength of these offsetting biases, the change in R&D spending during the temporary period could either over- or understate the impact of a permanent credit. Their analysis also indicated that a temporary tax credit would favor short-run R&D projects at the expense of long-term R&D projects.

Finally, when Barth et al. (1984) considered the incremental feature of the tax credit, their analysis showed that under some reasonable assumptions the incremental feature reduces the incentive effect of the credit for some firms during the temporary period. However, the temporary impact of the credit is likely to be the greatest in the year before its scheduled expiration date.

The above discussion clearly indicates that the impact of a temporary and incremental tax credit on firms' R&D spending behavior is not trivial. The impact of such a credit is expected to differ from one firm to another depending on the factors discussed above. Whether the net effect of the tax credit on the firms' overall R&D activities is significantly positive or not is an empirical question.

3.2.2 The Impact of ACRS

The ACRS allows firms to depreciate their R&D equipment over three years regardless of the actual economically useful life of such

equipment. However, R&D equipment will qualify for only a 6 percent investment credit rather than 10 percent. Thus, to evaluate the expected effect of ACRS on a firm's R&D spending behavior, the analysis should consider the impact of these two provisions on the cost of investment in R&D equipment and on a firm's cash flow.

By allowing firms to depreciate their R&D equipment for tax purposes faster than the actual economic depreciation firms can reduce their tax liabilities in the early years of the life of the asset. However, they will pay higher taxes in later years. Thus, the benefits from accelerated depreciation stem from the timing of tax payments, not from the absolute reduction of the tax burden. These benefits, however, will be offset by the reduction in the investment tax credit for R&D equipment. Whether the ACRS provides a tax incentive or disincentive to invest in R&D equipment depends on whether the relative advantage from depreciating the R&D equipment more rapidly is greater or smaller than the relative disadvantage of reducing the investment tax credit.

Barth et al. (1984) have shown analytically, as well as using illustrative cases from different industries, that the relative advantage of depreciating R&D equipment over a shorter time frame exceeds the relative disadvantages of qualifying for a lower investment tax credit in most cases. They show that ACRS reduces the required rate of return of R&D equipment relative to other capital investments. Hence, ACRS produces positive incentives for R&D equipment. They conclude that ACRS will tend to favor R&D activities in all industries. The incentives, however, will be greatest for those industries with the most capital intensive R&D.

3.2.3 Combined Effects of ACRS and the R&D Tax Credit

The previous discussion indicated that the R&D tax credit, in the absence of its incremental and temporary features, is expected to stimulate firms to increase their R&D expenditures. The effectiveness of this tax credit, however, is expected to be reduced by the incremental and temporary features of the credit. The extent to which the effectiveness of the credit would be reduced varies from case to case depending on various factors. ACRS alone is expected to positively influence investment in R&D equipment. Thus, it seems possible to expect that the combined effects of the R&D tax credit and the special treatment the ACRS gave to R&D equipment, along with the other tax incentives provided by ERTA, are likely to have a favorable impact on firms' R&D investments. The following hypothesis, therefore, is proposed:

Ho: The R&D tax incentives provided by the 1981 ERTA are not expected to stimulate R&D investments.

Ha: The R&D tax incentives provided by the 1981 ERTA are expected to stimulate R&D investments.

3.3 Summary

This chapter has discussed the conceptual development of the research hypotheses to be tested in this study. The discussion on the impact of SFAS No. 2 on firms' R&D activities indicates that SFAS No. 2 is expected to negatively influence capitalizers' R&D expenditures. With respect to the impact of the tax incentives provided by ERTA, this study expects a positive relationship between firms' R&D

expenditures and the R&D tax incentives provided by ERTA. These hypotheses will be empirically tested in Chapter VI.

3.4 Note

1. In addition to the R&D tax credit and ACRS, ERTA has offered firms two additional tax incentives: (1) an increase in the deduction permitted for contributions of research equipment to universities by an equipment manufacturer. Before ERTA, the deductions were equal to the cost of producing the equipment. After ERTA, firms can deduct an additional 50 percent of the difference between the cost and the market value, so long as the deduction is not more than twice the cost; and (2) a two-year suspension of Section 1.861-8 of the Internal Revenue Service Regulation, which requires multinational corporations to allocate a certain percentage of their R&D expenditures to income generated by their overseas operations. It has been argued that this regulation may have the effect of encouraging multinational firms to undertake more of their R&D activities overseas.

CHAPTER IV

DEVELOPMENT OF EMPIRICAL MODELS

Examining the impact of SFAS No. 2 and the 1981 ERTA on firms' R&D spending behavior requires the modeling of the economic determinants of R&D investment decisions. Assuming unchanged firm preferences for R&D activity in the absence of SFAS No. 2 (or ERTA) this model can be employed to predict the expected level of R&D investment in the absence of the event under investigation (i.e. SFAS No. 2 or ERTA). If such a prediction model is properly specified then the correlation between any observed unexpected changes in the levels of R&D expenditures and the release of SFAS No. 2 (or ERTA) may indicate the extent to which the introduction of the event under study influenced R&D.

In the case of SFAS No. 2, however, firms self select one of two groups: capitalizers or expensers. This self selection introduces possibly inconsistent, inefficient and biased estimates of the parameters of the R&D model (Maddala, 1983). To correct for self-selectivity and estimate consistent parameters for correct prediction (as will be discussed in Chapter V) a second model needs to be developed to explain the firm's choice of whether to capitalize or expense R&D expenditures.

The purpose of this chapter, therefore, is to develop two regression models. The first model explains the managerial R&D investment decisions (R&D model) and the second model explains the managerial choice of the R&D accounting method (AC model). Section

4.1 presents the economic determinants of firms' R&D investment decisions and section 4.2 develops the accounting choice model.

4.1 The Economic Determinants of Firms' R&D Investment Decisions

The R&D model developed in this section is formulated based on previous theoretical and empirical work in the R&D literature. Although many variables have been posited by previous studies as determinants of firm R&D spending behaviour, five are commonly selected as the most important factors influencing R&D activity: (1) firm size (SIZE); (2) the availability of cash flows (CASH); (3) the level of capital investment (CAP); (4) the extent of the firm's product diversification (DIV); and (5) the level of concentration of the industry in which the firm is operating (CONC).[1]

4.1.1. Firm Size

It has long been argued that firm size is an important factor in explaining firm R&D activity. This argument can be traced back to Schumpeter (1950) who asserted that a large firm size is a necessary condition for conducting R&D activity. Large firms have superior access to financial resources, better ability to diversify risk, and more efficient economies-of-scale than small firms. The Schumpeterian firm-size hypothesis, therefore, suggests that R&D activity is a positive and increasing function of firm size. Galbraith (1952) provides theoretical support to the Schumpeterian hypothesis, but he emphasizes the importance of firm size per se.

Critics of the Schumpeterian hypothesis [e.g., Mason (1951) and Nelson et al. (1967)] have argued to the contrary that large firms may have less incentive to invest in R&D because of the complexity of

their internal structure, the intensity of their bureaucratic decision making, and the low degree of competitive pressure to innovate. Scherer (1984) argues that because of economies-of-scale large firms can conduct R&D more efficiently than small firms. This cost-saving could lead to either lower R&D outlays or more R&D projects with increasing outlays. Scherer points out that whether or not the net R&D investments increase depends on the elasticity of project approvals with respect to how much scale-related cost-savings exceed unity.

Numerous empirical studies have examined the relationship between R&D activity and firm size. The results show that while the relationship between R&D and firm size, in general, is positive, the proportion to size varies from industry to industry. For example, Grabowski (1968) and Mansfield (1968) found that while R&D intensity increases with size in the chemical industry, the proportion is stable for the petroleum and pharmaceutical firms irrespective of size. On the other hand, Mueller (1967) and Smith and Creamer (1968) reported evidence suggesting that smaller firms in some industries spend more on R&D relative to their size than large firms. Loeb and Lin (1977) and Schrieves (1978) found R&D increases with firm size up to a point and then declines thereafter.

It is clear from the available empirical evidence that while, in general, firm size per se has positive correlation with R&D activity, there is some disagreement as to whether R&D is an increasing function of firm size. In this study, size is used as a determinant of R&D activity. In addition to the linear-size term, a squared-size term will be included in the model to examine whether R&D increases at faster or slower rate than firm size.

4.1.2 Cash Flows

The theoretical work of Kamien and Schwartz (1978) and Nelson and Winter (1982) has shown that the high degree of risk and uncertainty associated with R&D activities generates a binding external financing constraint and an increased dependency on internally generated funds for financing R&D. Similarly, Ben-Zion (1984) argues that, because of the secrets entailed in the R&D activities, firms are reluctant to reveal detailed information about their R&D projects that would make them attractive to outside lenders which makes them depend more on self financed R&D. Therefore, one can expect that firms with larger cash flows will spend more on R&D activities, than firms with a shortage in cash flows.

The known empirical evidence provides general support for the cash flow hypothesis. Mueller (1967), Grabowski (1968), Branch (1974), Armour and Teece (1980), Link and Long (1981), and Bozeman and Link (1984), among others, report results indicating that cash flows positively influence R&D activity.

In the light of the above discussion, I expect to observe positive association between cash flows and R&D expenditures. Assuming that firms plan for their R&D activities before or towards the beginning of each year, the expected effect is lagged. That is, last year's cash flows are more likely to affect the current year R&D activity.

4.1.3. Capital Investment

It has been argued that there exists an interdependent relationship between capital and R&D investment decisions. A firm's decision concerning either of these variables is likely to be made in the context of the other variable. Mueller (1967) contends that

capital investment and R&D are often alternative means to the same end.

Several studies have examined analytically and empirically the relationship between R&D and capital investment decisions in a simultaneous decision-making framework [Mueller (1967), and Grabowski and Mueller (1972)]. For example, Grabowski and Mueller reported a significant relationship between capital investment and R&D investment decisions, and that capital investment and R&D could be either complementary or competing on the firm's limited long term investment budget. This mixed relationship was also obtained by others. Minasian (1962), Mueller (1967) and Grabowski and Mueller (1972) found significant negative association between capital investment and R&D. To the contrary, the National Science Foundation (1964) and Crowell (1987) reported significant positive correlation between the two variables.

Regardless of the competitiveness or the complementarity between capital investment and R&D, the significance of the interdependency suggests that capital investment is an important factor in determining R&D. Both capital investment and R&D have substantial short run negative impacts on the firm's cash flows. It is reasonable then to assume that firms will be unlikely to undertake new R&D projects and increase their capital investment at the same time. Thus, it is expected that a negative relationship between capital investment and R&D will be found.

4.1.4 Product Diversification

Nelson (1959) asserts that, due to the uncertainty of the output of research activities, highly diversified firms, with "their fingers in many pies," will be better able to utilize the unforseen output of

R&D activity than less diversified firms.[2] Moreover, highly diversified firms may also have greater ability than narrowly diversified firms to reduce the risk inherent in R&D activities (Scherer, 1967). Thus, the higher the degree of diversification the greater the incentive for the firm to invest in R&D activity. The benefits of diversification, however, can be limited by operating within a complex system of decision-making channels (Scherer, 1984).

Empirical studies have found statistical association between the degree of product diversificant and R&D activity, but, as with capital investment, there is considerable disagreement about the direction of the relationship. Grabowski (1968), Kelly (1970), Link (1981, 1982), Link and Long (1981), and Bozeman and Link (1984) found significant positive association between diversification and R&D. On the other hand, Comanor (1965) found that diversification was negatively associated with R&D, suggesting that R&D effort may be productive if it concentrates on a few product areas. Scherer (1965) and Johannisson and Lindstrom (1971), however, found that diversification was not significant in explaining R&D activity.

Although the results of empirical studies are mixed, the predominance of the available evidence is in support of Nelson's hypothesis. This study, therefore, expects that great product diversification will positively influence R&D activity.

4.1.5 Industry Concentration

In addition to firm size, Schumpeter (1950) suggests that monopoly power is also an important determinent of R&D activity as reflected in a concentrated market structure. He argues that the reason research activities in highly concentrated industries are more

productive than in less concentrated industries is because monopoly power helps firms to reap the benefits of their R&D investments. That is, the greater the monopoly power the more R&D investments are undertaken. Galbraith (1952) provides support for the monopoly power hypothesis and posits that an industry consisting of a few large firms is an ideal instrument for inducing R&D activity. To the contrary, other researchers have argued that the incentives to invest in R&D are greater under competition than under monopolistic conditions [e.g. Arrow (1962) and Levin, Cohen, and Mowery (1985)].

Numerous empirical studies have examined the influence of market structure on R&D activity as reflected in concentration ratios (measured typically by the portion of industry sales attributable to the 4, 8, or 20 largest firms). The results thus far are mixed. While some studies found support for the hypothesis of positive association between concentration and the intensity of R&D [e.g. Scherer (1967), Comanor (1967), Kelly (1970), Rosenberg (1976), and Shrieves (1978)], other studies reported negative correlation between industry concentration and R&D activity [e.g., Adams (1970), Globerman (1973), and Bozeman and Link (1984)]. In addition, some other studies found little or no association between concentration and R&D activity [e.g., Horowitz (1962), Hamberg (1964), and Phlips (1971), and Link and Long (1981)].

Although the empirical evidence is mixed, the weight of the evidence appears to be in support of the concentration hypothesis. Therefore, this study expects to find a positive relationship between R&D and industry concentration.

Based on the arguments associated with these five variables, this study postulates that the firm's R&D activity (R&D) is expected to be influenced by its size (SIZE), the availability of internally

generated funds (CASH), the level of capital investment (CAP), the extent of product diversification (DIV), and by the extent of its industry concentration (CONC). In addition to the linear size term (SIZE), the model includes a squared-size term (SIZ-SQR). The following regression model, therefore, is posited:

$$R\&D = \overset{+)}{\beta_1} SIZE + \overset{(?)}{\beta_2}\ SIZ\text{-}SQR + \overset{(+)}{\beta_3}\ CASH + \overset{(-)}{\beta_4}\ CAP + \overset{(+)}{\beta_5}\ DIV + \overset{(+)}{\beta_6}\ CONC + U$$

where U is an error term.

4.2 Determinants of the Choice of R&D Accounting Method

During the last ten years, there have been numerous accounting studies investigating determinants of managerial choices among alternative accounting methods [e.g., Gordon (1964), Watts and Zimmerman (1978), Hagerman and Zmijewski (1979), Dhaliwal (1980), Bowen et al. (1981), Zmijewski and Hagerman (1981), and Daley and Vigeland (1983)]. The purpose of this section is to build on previous work in this line of research to develop a model that explains the managerial choice of the accounting method for reporting R&D costs.

This study postulates five factors that are expected to influence the choice for accounting method for R&D : (1) capital structure and debt covenants restriction (LEV); (2) firm size (SIZE); (3) volatility of reported earnings (NIV); (4) volatility of R&D (RDV); and (5) materiality of R&D expenditures (RDM).

4.2.1 Capital Structure and Debt Covenants Restriction

Previous studies have emphasized the relevance of capital structure in explaining management's motivation for accounting choice. Jensen and Meckling (1976) and Smith and Warner (1979) point out that

debtholders usually use restrictive covenants in debt agreements to minimize management's ability to transfer wealth from debtholders to stockholders. They contend that the more levered the firm the higher the probability of potential debtholders-shareholders transfer of wealth, hence, the greater the incentive to enter into restrictive covenants. Many of these restrictions are typically expressed in terms of accounting numbers such as limits on long term debt/total assets, dividend restrictions tied to net income, and limits on the debt/equity ratio. Violating these constraints results in technical default which gives debtholders the option of renegotiating or accelerating the maturation of debt.

Motivated by this line of argument, Dhaliwal (1980), Holthausen (1980), and Leftwich (1980), among others, hypothesize that highly levered firms will tend to choose accounting methods that result in higher or earlier reported earnings to relax the restrictions of debt covenants and avoid technical default.

Several empirical studies which examined this hypothesis provide supporting evidence [e.g., Deakin (1979), Dhaliwal (1980, 1982), Bowen Noreen, and Lacey (1981), Dhaliwal, Salamon, and Smith (1982), and Daley and Vigeland (1983)].

In light of the above discussion, I expect that highly levered firms capitalize R&D to avoid approaching limits of debt covenant constraints.

4.2.2. Firm Size

It has been argued that firm size could be an important factor of determining accounting choices. Gagnon (1967), Jensen and Meckling (1976), and Watts and Zimmerman (1978) assert that large firms are likely to be subjected to negative wealth transfer through

government intervention in the form of more regulation, higher corporate taxes, more antitrust laws, etc. For example, Gagnon (1967, p. 192) states:

> When a concern is large and profitable, it is more likely to have one of its mergers challenged by the Antitrust Division, to be forced to sell one of its profitable subsidiaries or to be publicly censured for its pricing policies. This implies that, everything else equal, the price to be paid for maximizing reported profits is higher for a large firm than for a small one.

Managers of large firms, therefore, may be motivated to reduce reported earnings to avoid political costs. In the same vein, Watts and Zimmerman (1978) hypothesize that large unregulated firms tend to select income decreasing accounting methods in order to minimize their political visibility and, hence, reduce the likelihood of political threats of wealth redistribution.

Empirical evidence provides partial support to the size hypothesis. Watts and Zimmerman (1978), Hagerman and Zmijewski (1979), Zmijewski and Hagerman (1981), Dhaliwal, Salamon, and Smith (1982), and Daley and Vigeland (1983), for example, lend support to the size hypothesis. The empirical evidence of some studies does not support the size hypothesis [e.g, Gagnon (1967), and Bowen, Noreen, and Lacey (1981)].

Based on the above argument, firm size can partially explain the chosen R&D accounting method. I expect that larger firms are likely to adopt the expensing method and that smaller firms are likely to adopt the capitalization method.

4.2.3. Volatility of Reported Earnings

In addition to the financial risk hypothesis which links the managerial choice of accounting methods to the firm's debt-to-equity ratio, a number of recent studies have argued that the business risk (as reflected in volatility of reported earnings) should be also simultaneously considered as a factor which may influence choices of accounting method [e.g., Hagerman and Zmijewski (1979), Dhaliwal (1984), and Lys (1984)]. Lys (1984) argues that omitting total firm risk from the analysis is likely to cause inefficient and biased coefficient estimates for the included variables because of the likely negative correlation between business risk and leverage. For instance, public utilities which have a relatively low business risk tend to have a high leverage ratio. Dhaliwal (1984) hypothesizes that firms with highly volatile earnings will have greater incentives to adopt accounting methods which reduce the variability of earnings (holding the financial leverage constant).

The relationship between volatility of the earnings stream and managerial choices of accounting methods can also be generated from the income smoothing literature. Gordon (1964) asserts that management maximizes its utility by choosing accounting methods that smooth reported earnings and smooth the rate of growth in earnings. Numerous empirical studies have examined this hypothesis. While the results vary considerably, they, in general, provide support for the smoothing hypothesis (see Ronen and Sadan, 1981).

I argue in this study, therefore, that managers who face a highly volatile earnings stream will have an incentive to select accounting methods that can act as built-in stabilizers of which capitalization of R&D is one. Therefore, capitalizing firms are likely to have a highly variable earnings stream, <u>ceteris paribus</u>. The volatility of

reported earnings will be measured by the variance of gross profit to capture the variability in earnings before the smoothing takes place.

4.2.4. Volatility of R&D Expenditures

The variance of gross profit is used to measure the pure business risk in the absence of all other sources that might increase earnings variability. For a given business risk, the variability of a firm's earnings is expected to increase as the variability of its R&D outlays increases. In this case, the income smoothing hypothesis predicts that managers of these firms will choose accounting methods that reduce the variability of reported earnings. Elliott et al. (1984) report results indicating that capitalizing firms tend to have highly variable R&D expenditures over time. Hence, it is expected that the higher the volatility of R&D expenditures the more likely it will be that the firm will adopt the capitalization method, everything else held constant.

4.2.5 Materiality of R&D Expenditures

Another factor which may influence the managerial choice of whether to expense or capitalize R&D expenditures is the magnitude of R&D outlays. The extent to which a firm invests in R&D varies considerably from firm to firm and from industry to industry. For example, the NSF annual survey (1980) reports that company financed R&D as a percentage of net sales varies across industries ranging from 0.5 percent in the petroleum industry to 5.6 percent in the professional and scientific instrument industry. Madden, McCullers, and Van Daniker (1972) report results indicating that R&D averages approximately 2.5 percent of sales and 50 percent of net income. Net income, therefore, is highly sensitive to the amount of R&D charged to

the income statement particularly for firms whose product lines are expected to have relatively limited revenue generating lives. Thus, it can be argued that the higher the relative magnitude of R&D costs to firm profits the more likely are managers to capitalize R&D costs and vice versa.

Based on the previous discussion, I posit five factors as influencing managers' decisions as to whether to capitalize or expense R&D expenditures. These are financial leverage (LEV), firm size (SIZE), volatility of reported earnings (NIV), volatility of R&D (RDV), and materiality of R&D expenditures (RDM). The accounting choice (AC) model, therefore, can be formulated as follows:

$$AC = \theta_0 + \overset{(+)}{\theta_1} LEV + \overset{(-)}{\theta_2} SIZE + \overset{(+)}{\theta_3} NIV + \overset{(+)}{\theta_4} RDV + \overset{(+)}{\theta_5} RDM + \epsilon$$

where AC is the observed dichotomous indicator of the R&D accounting method which takes a value of one for capitalizing and zero for expensing.

4.3 Summary

This chapter develops two regression models: The first model explains the R&D investment decisions and the second model explains the choice of the R&D accounting method. The next chapter discusses how these models are to be employed in testing the two research questions addressed in this study.

4.4 Notes

1. For a survey of previous studies and for a more detailed discussion of these and other variables see Scherer (1980, 1984) and Kamien and Schwartz (1982). Among these other variables, the amount of federal support received by firms for conducting R&D and the form of ownership are considered important factors in explaining firm R&D. These two factors, however, are ignored in this study largely because of data availability.

2. Although Nelson's hypothesis applies directly to basic research, many researchers believe that it applies equally to total R&D [e.g., Grabowski (1968), Kamien and Schwartz (1975), and Scherer (1980)].

3. For a review of this line of research see Holthausen and Leftwich (1983) and Kelly (1983).

CHAPTER V

RESEARCH METHODOLOGY

5.1 Research Methodology of Testing the Impact of SFAS No.2

The research methodology employed to examine the impact of SFAS No. 2 on firms' R&D spending behavior is a switching regression method.[1] This methodology can, in general, be applied to situations in which the economic system includes more than one regime (or option) from which individuals or firms (i.e. economic agents) make selections. The selection of one regime over another indicates the possibility of some fundamental or structural differences in the characteristics of the economic agents making the selection. Furthermore, switching from one regime to another (either voluntary or mandatory) is likely to be associated with changes in the behavior of economic agents. The switching regression analysis provides techniques for estimating, *a priori*, the potential changes in the behavior of economic agents that might result from switching from one regime to another (i.e. *ex-ante* analysis). In addition, the switching regression analysis helps refine the measurements used in testing the *post* reaction in the behavior of individuals after the switch occurred (i.e. *ex-post* analysis). The *ex-ante* and *ex-post* analyses together, therefore, constitute a powerful tool for examining the economic consequences of SFAS No. 2. Consistent results across both analyses will enhance and further validate the findings.

5.1.1 Ex-Ante Analysis

The first step toward examining the impact of SFAS No. 2 on firms' R&D spending behavior is to estimate the R&D model. Using the subscript i to denote the ith firm, the R&D model (developed in Chapter IV) can be written in the matrix notation as follows:

$$R\&D_i = \beta X_i + U_i \qquad (1)$$

where $R\&D_i$ is the observed R&D expenditures, β is a 1 x m vector of coefficients, X_i is an m x 1 vector of independent variables, and U_i is a random error term.

It is generally asserted that firms do not choose randomly from the available accounting alternatives and, thus, it is likely that the particular accounting method selected for reporting R&D costs is systematically related to certain characteristics of the firms [see, e.g., Gonedes (1979), Wolfson (1980)]. The fact that some firms choose to be capitalizers rather than expensers indicates that they may have characteristics different from those of expensers. Hence, it is reasonable to assume that the observations of R&D are generated by two distinct regression equations; that is,one R&D equation for capitalizers and a second for expensers. The explanatory variables, therefore, are expected to affect the dependent variable in the two groups differently. In addition, it is assumed that the variance of the disturbance term differs between the two groups.[2] More specifically, equation 1 can be rewritten as follows:

$$R\&D_{Ci} = \beta_1 X_{1i} + U_{1i} \qquad (2)$$

$$R\&D_{Ei} = \beta_2 X_{2i} + U_{2i} \qquad (3)$$

where $R\&D_{Ci}$ and $R\&D_{Ei}$ are the observed R&D expenditures by capitalizers and expensers respectively, and $\beta_1 \neq \beta_2$.

In an ideal experiment firms would be randomly assigned to each group. In this experiment, however, firms self select the two groups. This self selection introduces biases that result in inconsistent estimates of the parameters β_1 and β_2 (Maddala, 1983, pp. 257-267). To correct this self-selection bias the accounting choice model (developed in Chapter IV) is used. Using subscript i to denote the ith firm, the accounting choice model can be written in the matrix notation as follows:

$$AC_i = \theta Z_i - \epsilon_i \qquad (4)$$

where AC_i is an index of a firm's preference either to capitalize expenditures (AC=1) or to expense them (AC=0), θ is a 1 x n vector of coefficients, Z_i is an n x 1 vector of independent variables, and ϵ_i is a random error term.

What we have here is a switching regression model where the sample separation is known. The model consists of three equations and can be written as follows:

$$R\&D_{Ci} = \beta_1 X_{1i} + U_{1i} \qquad (5.1)$$

$$R\&D_{Ei} = \beta_2 X_{2i} + U_{2i} \qquad (5.2)$$

$$AC_i = \theta Z_i - \epsilon_i \qquad (5.3)$$

An important feature of this structure is that the covariance matrix of (U_{1i}, U_{2i} and ϵ_i) is trivariate normally distributed with the following properties [see Heckman (1976), Lee (1978), and Maddala (1983)]:

$$\mathrm{Cov}\ (U_{1i},\ U_{2i},\ \epsilon_i) = \begin{vmatrix} \sigma_1^2 & \sigma_{12} & \sigma_{1\epsilon} \\ \sigma_{21} & \sigma_2^2 & \sigma_{2\epsilon} \\ \sigma_{1\epsilon} & \sigma_{2\epsilon} & 1 \end{vmatrix},$$

$$E\ [U_{1i} | \epsilon_i < \theta Z_i] = E\ [\sigma_{1\epsilon} \epsilon_i | \epsilon_i < \theta Z_i]$$

$$= -\ \sigma_{1\epsilon} \frac{\phi(\theta Z_i)}{\Phi(\theta Z_i)}, \text{ and}$$

$$E\ [U_{2i} | \epsilon_i \geq \theta Z_i] = E\ [\sigma_{2\epsilon} \epsilon_i | \epsilon_i \geq \theta Z_i]$$

$$= \sigma_{2\epsilon} \frac{\phi(\theta Z_i)}{1 - \Phi(\theta Z_i)}.$$

The model assumes that $R\&D_{Ci}$ and $R\&D_{Ei}$ are mutually exclusive; that is, one either observes the firm capitalizing all R&D costs or expensing all of them.

Due to the presence of correlated disturbance terms (i.e. ϵ is correlated with U_1 and U_2) whose expectations are not zeros, equations 5.1 and 5.2 cannot be consistently estimated using Ordinary Least Squares (OLS) [Goldfield and Quandt (1976), Lee (1978), and Maddala (1983)]. Furthermore, the usual assumption that $E(U_1^2) = {\sigma_1}^2$ and $E(U_2^2) = {\sigma_2}^2$ is no longer attainable.

To avoid the inconsistency of estimation resulting from the concerns mentioned above, the two-stage estimation techniques proposed by Heckman (1976) are employed to correct for self selectivity and obtain consistent estimates of β_1, β_2, $\sigma_{1\epsilon}$, and $\sigma_{2\epsilon}$.[3] The purpose of

the procedure is to estimate E $[U_{1i}|AC = 1]$ and E $[U_{2i}|AC = 0]$ and adjust the error terms so that their expected values become zero. In the first stage, the sample separation function (equation 5.3) is estimated for the combined samples using the probit (maximum likelihood) procedure in order to obtain the estimates for the correction terms $\frac{\phi(\hat{\theta Z_i})}{\Phi(\hat{\theta Z_i})}$ for each sample observation in the capitalizing group (ACM_C) and $\frac{\phi(\hat{\theta Z_i})}{1-\Phi(\hat{\theta Z_i})}$ for each sample observation in the expensing group (ACM_E). These two correction terms are then added to equations 5.1 and 5.2, respectively, to obtain consistent estimates of β_1 and β_2 and to asses the significance of the accounting method choice in determining R&D investment decisions for each group. Equations 5.1 and 5.2, then, can be rewritten as follows:

$$R\&D_{ci} = \beta_1 X_{1i} - \sigma_{1\epsilon} \frac{\phi(\hat{\theta Z_i})}{\Phi(\hat{\theta Z_i})} + \omega_{1i} \tag{6}$$

$$R\&D_{Ei} = \beta_2 X_{2i} + \sigma_{2\epsilon} \frac{\phi(\hat{\theta Z_i})}{1 - \Phi(\hat{\theta Z_i})} + \omega_{2i} \tag{7}$$

where $\sigma_{1\epsilon}$ = Cov (U_1, ϵ), $\sigma_{2\epsilon}$ = Cov (U_2, ϵ), $\phi(\hat{\theta Z_i})$ = the standard normal density function evaluated at $(\hat{\theta Z_i})$, $\Phi(\hat{\theta Z_i})$ = the cumulative

distribution of a standard normal function evaluated at $(\hat{\theta Z_i})$, and ω_{1i} and ω_{2i} are random error terms.

In the second stage, equations 6 and 7 will be estimated using OLS and, hence, consistent estimates of β_1, β_2, $\sigma_{1\epsilon}$, and $\sigma_{2}\epsilon$[4] will be obtained. The impact of SFAS No. 2 on capitalizers' R&D spending will be assessed by the statistical significance of the value of $\hat{\sigma}_{1\epsilon}$. If the capitalization accounting method is not an important factor in explaining capitalizers' R&D expenditures then the coefficient of $\hat{\sigma}_{1\epsilon}$ should not be significantly different from zero. Consequently, one would expect that forcing capitalizers to adopt the expense method to have no effect on their R&D spending. The null hypothesis of no effect of SFAS No. 2 on capitalizers' R&D expenditures can, therefore, be stated as follows:

H_o: $\sigma_{1\epsilon} = 0$

If the above null hypothesis is rejected , then the natural follow up question would be: "To what extent are capitalizers expected to reduce their R&D investments in response to SFAS No. 2?". The potential reduction in capitalizers' R&D expenditures in response to SFAS No. 2 will be estimated as follows:

$$R\&D_{Ci} - E\,[R\&D_{Ei}|AC = 1] = R\&D_{Ci} - [\hat{\beta}_2 X_{1i} + \hat{\sigma}_{2\epsilon} \frac{\phi(\hat{\theta Z_i})}{\Phi(\hat{\theta Z_i})}] \quad (8.1)$$

The above equation estimates the monetary effect on R&D investments that is expected to result from removing the deferral option and forcing capitalizers to switch to the expense method. This

expected reduction in R&D equals the difference between the actual amount spent on R&D activity under the capitalization method (before the implementation of SFAS No. 2, e.g. 1973) and the equivalent amount of R&D expenditures that would have been spent by the same firm during the same year if it had adopted the expense method.[5] This difference provides an upper bound for the impact of the regulatory intervention. If this difference is not significantly different from zero, then one would expect that forcing capitalizers to switch to the expense method to have no effect on their R&D investments. The null hypothesis of no effect of SFAS No. 2 on capitalizers' R&D expenditures can be formulated as follows:

$$H_o:\ R\&D_{Ci} - E[R\&D_{E_i} | AC = 1] = 0.$$

The above hypothesis will be tested using the t-test. To reduce the test sensitivity to extreme values, and the Wilcoxon Matched-Pairs Signed-Ranks test will also be employed.

Although the main purpose of the statistical analysis presented above has been to estimate, a priori, the potential impact of implementing SFAS No. 2 on capitalizers' R&D spending behavior, a useful byproduct of such an analysis is that it allows us to estimate what the reaction of expensers would have been if SFAS No. 2 had eliminated the expense method instead. This estimate will provide additional evidence about the robustness of using switching regression analysis in examining the (potential) economic consequences of mandatory accounting changes, will enhance the validity of the findings of the ex-ante analysis, and will improve our understanding of the managerial choice among available accounting methods. To do

so, the above analyses (i.e. assessing the statistical significance of including the correction term $\frac{\phi(\hat{\theta}Z_i)}{1 - \Phi(\hat{\theta}Z_i)}$ on the expensers' R&D function and estimating the potential change in expensers' R&D investments if they were forced to switch to the capitalization method) will be repeated for the expense group. To estimate the monetary effect on expensers' R&D investments if they were forced to adopt the capitalization method, the following prediction errors will be estimated (using coefficients from the capitalizers' equation):

$$R\&D_{Ei} - E\ [R\&D_{Ci} | AC = 0] = R\&D_{Ei} - [\hat{\beta}_1 X_{2i} - \hat{\sigma}_{1\epsilon} \frac{\phi(\hat{\theta}Z_i)}{1 - \Phi(\hat{\theta}Z_i)}] \quad (8.2)$$

5.1.2 Ex-Post Analysis

The purpose of the ex-post analysis is to examine the post-switch reaction of capitalizers to the implementation of SFAS No. 2. Having corrected for self selectivity and estimated the regression models (equations 6 and 7) by OLS using 1973 data, the reaction of capitalizing firms to the implementation of SFAS No. 2 will be assesed assessed using tests for structural change in the R&D model.

To examine possible structural change in the R&D function of capitalizing firms after the implementation of SFAS No. 2, the R&D model is formulated as follows:[6]

$$R\&D_C = \alpha_{1B} + \beta_{1B} X + u \qquad \text{Before 1974} \qquad (9)$$

$$R\&D_C = \alpha_{1A} + \beta_{1A} X + u \qquad \text{After 1974} \qquad (10)$$

where α_{1B} and α_{1A} are the intercept terms before 1974 and after 1974, respectively, β_{1B} is a 1 x k vector of coefficients of the independent variables before 1974, β_{1A} is a 1 x k vector of coefficients of the independent variables after 1974, and X is a k x 1 vector of explanatory variables.

The effect of the new regime (i.e. SFAS No. 2) will be manifest in the regression parameters. Fitting each model (i.e. equations 9 and 10) by OLS produces a residual sum of squares. Three basic tests for structural change can then be conducted using the F test [see Johnston (1984), pp. 207-225]:

1. Testing for structural change in the model as a whole (i.e. both slopes and intercepts), where the null hypothesis can be stated as:

$$H_o: \begin{pmatrix}\alpha_{1B} \\ \beta_{1B}\end{pmatrix} = \begin{pmatrix}\alpha_{1A} \\ \beta_{1A}\end{pmatrix}$$

2. Testing for structural change in the intercepts, where the null hypothesis can be stated as:

$$H_o: \alpha_{1B} = \alpha_{1A}$$

3. Testing for structural change in the slopes, where the null hypothesis can be stated as:

$$H_o : \beta_{1B} = \beta_{1A}$$

The F test examines the joint effects of all parameters on the dependent variable. Hence, tests for structural change do not provide an unequivocal answer about the direction of the net effect of the changes in the parameters on R&D expenditures. To determine the

direction of the change, the following two equations will be estimated:

$$\overline{R\&D}_{tB} = \hat{\alpha}_{tB} + \hat{\beta}_{tB}\bar{X}_{tB} \qquad (11)$$

$$\overline{R\&D}_{tA} = \hat{\alpha}_{tA} + \hat{\beta}_{tA}\bar{X}_{tB} \qquad (12)$$

where tB = the time period before the intervention of SFAS No. 2 (1973), tA = the time period after the intervention of SFAS No. 2 (1975-1978), $\hat{\alpha}_{tB}$,$\hat{\alpha}_{tA}$, $\hat{\beta}_{tB}$,$\hat{\beta}_{tA}$ are the estimated coefficients obtained from estimating equations 9 and 10, $\bar{X}_{tB}$ is the overall average of the independent variables in 1973, and $\overline{R\&D}_{tB}$ and $\overline{R\&D}_{tA}$ are the predicted value of R&D evaluated at the mean values of the independent variables in 1973.

If tests of structural change show significant results, equations 11 and 12 will be evaluated and compared. If the estimated value of equation 12 is greater than 11, this would indicate increase in R&D spending after 1974, and vice versa.

5.2 Research Methodology of Testing the Impact of ERTA

The research methodology used to examine the effectiveness of the R&D tax incentives provided by the ERTA of 1981 in stimulating firms' R&D activities is similar to that used to examine firms' post reaction to the implementation of SFAS No. 2 except that the analysis here is conducted in a time-series cross-sectional framework.[7]

To examine possible structural change in the R&D function, the R&D model developed in Chapter IV is formulated as follows:

$$R\&D_{itB} = \alpha_{itB} + \beta_{itB}X_{itB} + U_{1tb} \qquad (13)$$

$$R\&D_{itA} = \alpha_{itA} + \beta_{itA}X_{itA} + U_{2tA} \qquad (14)$$

where i = 1, 2, ..., N is the cross-sectional firms, tB = the time period before the intervention of ERTA (1978-1980), tA = the time period after the intervention of ERTA (1982-1984), β_{it} is a 1 x j vector of coefficients of the independent variables before 1981, β_{itA} is a 1 x j vector of coefficients of the indendent variables after @1981, $X_{it\beta}$ is a j x 1 vector of explanatory variables before 1981, X_{itA} is a j x 1 vector of explanatory variables after 1981, and U_1 and U_2 are error terms.

The data cover two distinct periods: n_1 observations relating to the period before the intervention of the ERTA of 1981 (1978-1980) and n_2 observations relating to the period after the intervention of the ERTA of 1981 (1982-1984). Analogous to the previous analysis, the null hypothesis of no structural change can be set as:

$$\text{Ho: } \begin{pmatrix} \alpha_B \\ \beta_B \end{pmatrix} = \begin{pmatrix} \alpha_A \\ \beta_A \end{pmatrix}$$

Similar to the statistical analysis performed in Section 5.1.2.1, three basic tests for structural changes will be conducted in this section: (1) test of differential intercepts, (2) test of differential slope coefficients, and (3) test of differential

regressions (both intercepts and slopes together). As explained earlier, the F test examines the joint effects of all parameters on the dependent variable. To determine the direction of the change, equations 11 and 12 will be evaluated at the overall mean values of the independent variables during the period (1978-1980).

5.3 Sample Selection

As discussed in section 5.1, the two-stage switching regression analysis is used to examine the economic consequences of SFAS No. 2. This analysis utilizes two groups of firms: an experimental group consisting of a set of firms which capitalized R&D costs prior to the issuance of SFAS No. 2 and a control group consisting of a set of firms that expensed R&D costs before the issuance of SFAS No. 2.

Capitalizing firms were identified by reference to the Disclosure Journal Index of Corporate Events during the period from May 1974 through April 1976. From a set of 450 firms identified as prior capitalizers of R&D, 169 capitalizing firms were randomly selected. To be included in the experimental sample, a firm must (a) switch to the expensing method after 11/30/1974, and (b) spend, on average, at least one percent of sales on R&D during the period 1972-1974. These selection criteria were confirmed by examining 10-K's and annual reports.

The experimental sample of 169 firms were selected as follows. Initially, a total of 450 firms were identified as capitalizers. Of these, 143 were eliminated because they had switched to the expense method before November 30, 1974. Of the remaining 307 firms, an additional 75 firms were eliminated because they were not available on

the COMPUSTAT data base starting from 1976 for various reasons such as they had gone out of business, been acquired by another firm, or had merged with another company. In addition, 63 firms were dropped from the sample because they did not satisfy the criterion for minimum one percent of sales in average R&D expenditure. Although the final sample consists of 169 firms, the tests are conducted on a number of firms ranging from 121 in 1973 to 103 in 1978 because of the inconsistency in data reporting.

A control sample consisting of 250 firms was randomly selected from all firms available on the COMPUSTAT tapes but were not included in the experimental sample. To be included in the control sample a firm must (a) adopt the expense method at least one year before 1974, and (b) spend, on average, at least one percent of sales on R&D during the period 1972-1974. These selection criteria were also confirmed by examination of 10-K's and annual reports. Because of missing data in some years of the analysis, the tests are conducted using a number of firms ranging from 227 to 165 control firms.

To examine the effectiveness of the ERTA of 1981 in stimulating firms' R&D investments, a sample of 260 firms was selected randomly from all firms available on the COMPUSTAT tapes for the period 1978-1984. To be included in the sample, a firm must spend, on average, at least one percent of sales on R&D during the period 1978-1980. The year of 1981 was excluded from analysis because it was considered to be a transition period.

5.4 Summary

In this chapter I presented the research methodology and design employed in examining the two research questions addressed in this study . The impact of SFAS No. 2 on firms' R&D spending behavior is investigated both *ex-ante* and *ex-post*. The *ex-ante* analysis is conducted using the two-stage switching regression technique. The *ex-post* analysis and the examination of the effectiveness of the ERTA of 1981 on firms' R&D investments are conducted using tests for structural changes.

5.5 Notes

1. This method was originated by Quandt (1958, 1960) and has been applied in different fields including union membership, choice of occupation, housing, schooling, and labor force participation. For a survey of methodology and application see Goldfield and Quandt (1976) and Amemiya (1981).

2. In order to examine whether the two equations represent two different groups of firms which are structurally different a Chow test will be employed. If a significant F-value is found this would indicate that the two groups have different structures. Hence, the sample separation would be maintained and the two sets of parameters (β_1 and β_2) should be estimated separately. Otherwise, the subsamples would be pooled and a single parameter estimate should be obtained. For more discussion, see Goldfield and Quandt (1976).

3. A similar procedure has also been suggested by Lee (1978).

4. Maddala (1983) points out that estimating equations 6 and 7 using OLS underestimates the true variances since the correction terms $\dfrac{\phi(\hat{\theta}Z_i)}{\Phi(\hat{\theta}Z_i)}$ and $\dfrac{\phi(\hat{\theta}Z_i)}{1-\Phi(\hat{\theta}Z_i)}$ are estimated. Lee (1978) suggests that using a generalized least squares procedure may increase the efficiency of the estimates. Maddala (1983) provides techniques for correcting this problem. However, he states in a footnote that "The estimated variances from the OLS, taking into account heteroscedasticity, will underestimate the true variances. This is not true if heteroscedasticity has not been taken into account in the OLS estimation"(p. 227). Given the results obtained from OLS, the sample size, and the fact that I did not take into account heteroscedasticity, I don't expect that underestimating the true variances will significantly affect the results.

5. Note that $\hat{\beta}_2$ and $\hat{\sigma}_{2\epsilon}$ are used instead of $\hat{\beta}_1$ and $\hat{\sigma}_{1\epsilon}$.

6. Note that equation 9 should be estimated via two stage estimation procedures. Therefore, $\hat{\beta}_{1B}$ represents the estimated coefficients after correcting for self-selection bias.

7. A justification of combining time-series and cross-sectional data in estimating the parameters of the R&D model is to obtain more reliable estimates and, hence, better prediction than those obtained from the application of using only cross sectional estimation.

CHAPTER VI

EMPIRICAL RESULTS

This chapter presents the empirical results and implications of the analyses described in the previous chapter. Section 6.1 describes the procedures used to measure the dependent and independent variables in the R&D and accounting choice models. Section 6.2 reports the empirical results on the economic consequences of SFAS No. 2, while Section 6.3 presents the results on the effectiveness of the ERTA of 1981 in stimulating firms' R&D investments.

6.1 Variable definitions and Measurement

6.1.1. Operational Definitions of Variables Included in the R&D Model

Table 6.1 summarizes the operational definitions of variables included in the R&D model and the hypothesized signs of their coefficients. The procedures used in measuring the dependent and independent variables are discussed below.

Firms' R&D activities are measured by the dollar amount spent on R&D as reported on the COMPUSTAT tapes. However, the use of nominal dollars as a surrogate measure for R&D is sensitive to distortion because of inflation. Therefore, historical R&D expenditures are converted to constant dollars using the Gross National Product Implicit Price Deflators (1982 is used as the base year).

The analysis is conducted basically in a cross-sectional framework. Hence, using the absolute level of R&D expenditures as a

dependent variable might cause heteroscedasticity, particularly if the sample includes firms which are substantially different in size. One way of solving this problem is to normalize R&D spending by scaling the variables in the model by sales or total assets as proxies for size. Kuh and Meyer (1955) point out that estimating the deflated model via least squares yields more efficient and less biased estimates than the undeflated model only if the dependent variable is a linear function of the deflator. Otherwise, deflation would itself contribute to heteroscedasticity. Most results of prior research suggest that patterns in the relationship between firm size and R&D spending differ across industries(Kamien and Schwartz,1982). In the preliminary analysis of this study, the results show that R&D is not a linear function of firm size of sample firms. Therefore, according to the argument of Kuh and Meyer (1955) argument, scaling the R&D model by a measure of firm size as a common denominator might introduce heteroscedasticity rather than reduce it. In addition, it could be argued that a change in the R&D/size ratio may reflect a change in size (e.g. sales) and does not necessarily indicate a change in R&D spending. This measure of R&D, therefore, could potentiallly confound the results.

Another problem that must be considered here, which might also confound the results, is that firms' propensity to invest in R&D may be systematically related to certain industry characteristics. Hence,it can be argued that observed changes in R&D after the intervention of the events under investigation (i.e. SFAS No. 2 and ERTA of 1981) might be caused by industry-specific effects rather than by the intervention. One way to control for industry-specific is by scaling the absolute dollar amount of the dependent and independent

variables included in the R&D model by their respective industry averages.[1]

The two research problems investigated in this study, therefore, will be tested using an R&D model measured by the absolute dollar amounts (RD model), and a scaled R&D model where each variable in the model is divided by its corresponding industry average (RDR model).

The independent variables used in estimating the R&D model are firm size, cash flow, capital investment, product diversification, and industry concentration. The procedures used to measure each of these variables are described below.

Firm size has been alternatively measured in previous studies by sales volume, assets, or number of employees. Scherer (1965) discusses the features of these three measures. He finds that they are imperfectly positively correlated and that the choice among them is arbitrary. This study uses total assets as a proxy for size for the following reasons: (1) sales volume is more volatile than total assets, (2)the preliminary analysis of this study indicates a lower correlation between the cash flow variable and total assets rather than sales volume, and (3) R&D is a long term investment and is more likely to be associated with total assets than with projected sales or the number of employees. To examine the Schumperterian hypothesis that larger firms spend more on R&D relative to their size than smaller firms, a squared size term is included in the R&D model along with the linear size term.

The second explanatory variable in the R&D model is an index of the cash flow available for each firm. Following Largacy and Stickney (1980), Gambola and Ketz (1983), and Bowen, Burgstahler, and Daley (1987) the cash flow variable is measured as follows:

Cash flow = net income before extraordinary items
+ depreciation, amortization, and depletion
+ change in current liabilities from operations
- change in non-cash current assets from operations.

The cash flow is lagged one period to reflect the fact that R&D decisions are typically made before or at the beginning of each year. The data on cash flow is obtained from the COMPUSTAT tapes. The capital investment variable is measured by the total amount of capital expenditures as reported by COMPUSTAT.

The fourth explanatory variable in the R&D model is an index of the extent of each firm's product diversification. This index is formulated to reflect the number of markets serviced by each firm. A firm's degree of diversification, therefore, is measured by the number of four-digit industries in which the firm operates.[2] The data on diversification during the period 1978-1984 are obtained from the COMPUSTAT tape (Line of Business file). The data on firms' product diversification during the period 1973-1978 were collected by hand from Moody's Industrial Manual and Moody's OTC Manual.

Finally, the industry concentration variable is measured by the eight-firm concentration ratio corresponding to the three-digit SIC industry level.[3] That is, the industry concentration ratio is measured as the fraction of the total industry sales accounted for by the top eight firms in each industry at the three-digit SIC level.

6.1.2 Operational Definitions of Variables Included in the AC Model

Table 6.2 summarizes the operational definitions and expected signs of coefficients of the variables included in the accounting choice model.

The dependent variable in the accouting choice model is a univariate dichotomous variable which takes the value of one if the firm is a previous capitalizer, and zero otherwise. Daley and Vigeland (1984) argue that the choice available to the firm is a continuum and that some firms may capitalize a portion of R&D costs and expense the remainder. Although this point is valid, it is difficult to obtain such data. Therefore, it is assumed that firms either capitalize the entire R&D costs or expense them.

The explanatory variables included in the model are leverage, firm size, volatility of R&D expenditures, volatility of earnings, and the significance of R&D investment. The procedure used to measure firm size was discussed in the previous section, and is operationalized here by the logarithm of total assets. The procedures used in measuring the remaining explanatory variables are described below.

A proxy index of firm leverage is constructed by dividing the book value of the debt by the value of the firm, where firm value is defined as the market value of equity plus the book value of debt. The data used in constructing this index are obtained from the COMPUSTAT tapes.

Volatility of earnings is measured by the variance of gross profit over the 1966-1973 period for each sample firm. The reason for using gross profit rather than net earnings in computing the variance is to capture the variability in earnings before smoothing takes place. Volatility of R&D is also measured by the variance of R&D

expenditures over the 1966-1973 period. Finally, the significance of R&D expenditures for each firm is measured by dividing the average R&D expenditures (during the 1970-1973 period) by the average net income after taxes during the same period. All the data used in computing earnings variance, R&D variance, and the significance of R&D expenditures are obtained from the COMPUSTAT tapes.

6.2 Results of Testing the Impact of SFAS No. 2

6.2.1 Results of Ex-ante Analysis

Before the two-stage switching regression analysis was employed, several preliminary steps had been conducted. First, the R&D model was estimated for the capitalizing sample and the expensing sample separately.

Having estimated the R&D model for each group of firms, the next step was the examination of whether the regression coefficents were significantly different between the two groups of firms. This was done in order to determine whether the sample separation should be maintained. An F test was conducted on the two sets of regression coefficients for capitalizing and expensing samples for both the RD and RDR models.

Table 6.3 presents the results of testing for the homogeneity of regression slopes and/or intercepts. The results clearly indicate that the two groups of firms have quite different structural relationships for the R&D function. The F-values in testing for differential regressions (i.e. testing for both slopes and intercepts together), differential slopes, and differential intercepts are all highly significant at the 0.001 level for both RD and RDR models (except testing for differential intercepts for the RDR model which was significant at the 0.06 level). Consequently, the null hypothesis

of no structural differences between the two groups of firms is rejected, and leads to the conclusion that the relationship between the dependent and independent variables in the R&D model is quite different in the two groups of firms. Hence, the sample separation should be maintained.

6.2.1.1 First Stage Results

In the first stage, the accounting choice model (equation 5.3) is estimated on a sample of 367 firms (169 capitalizing firms and 198 expensing firms) using maximum likelihood probit analysis.[4] The regression results are presented in table 6.4. The model possesses good overall explanatory power. The Log Likelihood is -70.28 and the average likelihood is 0.825. The classificatory ability of the model is also very high. Ninety percent of the firms in the sample (i.e. 331 firms out of a total sample of 367 firms) are correctly classified.

All the estimated coefficients have the postulated signs and are statistically significant at conventional levels. The estimated coefficient on the leverage variable is positive and statistically significant at the 0.01 level. This result strongly suggests that highly levered firms are more likely to select the capitalization method and low leverage firms are more likely to choose the expense method. This finding is consistent with the results reported by Bowen et al. (1981) and Daley and Vigeland (1983), and provides support for the hypothesis that leverage and accounting procedure choice are related.

The estimated coefficient on the size variable is, as expected, negative and statistically significant at the 0.01 level. This result

indicates that small firms are more likely to select the capitalization method while large firms tend to select the expense method. This finding provides support for the hypothesis that large firms tend to choose accounting procedures that reduce current period reported earnings while small firms prefer accounting methods that increase current reported earnings.

The positive and statistically significant coefficient on the volatility of R&D expenditures variable indicate that firms with highly volatile R&D expenditures are more likely to select the capitalization method than firms with low variability. This result provides support for the income smoothing hypothesis. Similarly, the positive and statistically significant coefficient on the earnings variability variable suggests that firms with highly variable earnings are more likely to choose the capitalization method. While the coefficient estimate on earnings variability is directionally consistent with the prior expectation, and is statistically significant at the 0.01 level, it is, however, practically zero.

Finally, the estimated coefficient on the materiality of R&D expenditures is also positive and statistically significant at the 0.05 level. This result indicates that firms that spend significant portions of their income on R&D are more likely to choose the capitalization method than firms that spend insignificant amounts. This finding, again, provides some support for the income smoothing hypothesis.

As explained in the previous chapter, the estimated coefficients of the accounting choice model are used to estimate the standard normal cumulative function and the density function for each firm in the sample. The ratio of the density distribution to the standard normal cumulative distribution (ACM) is then added to the R&D model to

correct for self selection bias and estimate the significance of eliminating the selected accounting method on firms' R&D spending.

6.2.1.2 Second Stage Results

Having corrected for self selection bias, the next step of the analysis involves an OLS estimation of the R&D model for each group of firms. The regression results of estimating both the RD and RDR models are presented in table 6.5 for the capitalization group and in table 6.6 for the expensing group. For comparison purposes, the results of estimating both the RD and RDR models before correcting for self selection bias are also reported in these tables.

An examination of tables 6.5 and 6.6 indicates that, in general, the overall explanatory power of the R&D model is quite good in both samples and for both models. However, the R^2 in the capitalizing group dropped by an order of magnitude (91.25 for RD model and 44.64 for RDR model) after controlling for industry-specific effects. Following is a detailed discussion of the regression results reported in tables 6.5 and 6.6.

The estimated coefficient on the size variable is, as expected , positive and statistically significant at the 0.01 level in both models for the two samples. As explained earlier, a square size term was included to examine whether firms' R&D expenditures increase or decrease more than proportionately with an increase in firm size. The estimated coefficient on the squared size term exhibits quite different behavior in the two groups of firms. While the estimated coefficient on the square size term is negative and statistically significant at the 0.01 level for the capitalizing sample, it is positive and statistically significant at the 0.01 level for the

expensing sample. These results indicate that while firm size is, in general, a significant determinant of firms' R&D spending for both capitalizers and expensers, the two groups of firms behave differently toward R&D as firm size increases. For the capitalizing group, large firms spend less on R&D relative to their size than their small competitors. In contrast, large expensers spend proportionately more on R&D relative to their size than do smaller firms. Although these results suggest a nonlinear relationship between firm size and R&D expenditures, they do not provide convincing support for the Schumpeterian hypothesis.

The estimated coefficient on the cash flow variable in the RD model for the capitalizing firms has a positive sign, but it is not significantly different from zero. However, when industry-specific effects are taken into account, the cash flow variable is statistically significant and remains positive. For the expensing group, the estimated coefficient on the cash flow is positive and statistically significant at the 0.01 level in both models. These results provide support for the argument that the availability of internally generated funds is an important factor in explaining firms' R&D spending decisions.

The estimated coefficient on the capital investment variable, as expected, is negative and statistically significant at the 0.01 level in both groups of firms and for both models. This result strongly suggests that capital investment and R&D investment are competing for a firm's limited budget.

Contrary to the prior expectation of a positive association between firms' product diversification and R&D spending, the estimated coefficient on the diversification variable is consistently negative and statistically significant in both models and for both groups of

firms. This result suggests that highly diversified firmspend less on R&D activities than do less diversified firms. This result is similar to those reported by Cameron (1965), Scherer (1965), and Johannisson and Lindstrom (1971). There are two possible explanations for this finding. First, the R&D effort may be more productive if it is concentrated in a few product areas (Kamien and Schwartz, 1982). Second, the number of industries in which the firm operates may be a poor proxy for the degree of diversification.

The estimated coefficient on the seller concentration variable in the RD model is statistically significant, but in the wrong direction. When controlling for industry-specific effects, however, the seller concentration loses its significance and remains directionally inconsistent with prior expectation. These results suggest that firms in highly concentrated industries spend less on R&D activities than do firms in less concentrated industries. This finding does not provide support for the Schumpeterian hypothesis.

Of greater concern and more import to this study is whether the inclusion of the correction term ACM (representing the accounting choice variable) has indeed corrected for any existing self-selection bias, and to evaluate the significance of removing the accounting choice on the R&D function. These will be assessed by (i) the statistical significance of the t-value of the ACM variable, and (ii) the improvement in the statistical fit after including the correction term in the R&D model.

The estimated coefficient on the correction term for the capitalizing group ($\hat{\sigma}_{1\epsilon}$) has the predicted sign and is statistically significant at the 0.01 level in both the RD and RDR models. This result indicates that the capitalization accounting method is a

significant determinant of the R&D function for capitalizing firms. Thus, omitting the accounting choice variable would result in a misspecified model. After including the ACM_C variable, the concentration variable in the RD model and the intercept term of the RDR model gained statistical significance. The estimated coefficients on the other variables in both models are, in general, slightly higher and some improvement in their levels of statistical significance occurs. These results suggest that eliminating the capitalization method will likely affect the capitalizers' R&D function.

For the expensing sample, the estimated coefficient on the correction term (i.e., $\hat{\sigma}_{2\epsilon}$) is not significantly different from zero. The inclusion of the ACM_E variable had little effect on the estimated coefficients of the other independent variables in the R&D model. Examining table 6.6 indicate that after, including the ACM_E variable, the estimated coefficients on the other independent variables in both the RD and RDR models remained virtually unchanged with the same level of statistical significance. These results suggest that the expensing accounting method is not a significant determinant of expensers' R&D activities.

To estimate the extent to which capitalizing firms are expected to change their R&D expenditures in response to the elimination of the capitalization method equation 8.1 in Chapter V is estimated. This potential change is defined as the difference between the actual amount spent on R&D by a capitalizing firm in 1973 under the capitalization method and the equivalent amount of R&D expenditures that would have been spent by the same firm if forced to use the expense method in 1973. The significance and the direction of this

unexpected change in R&D spending is examined using the t-test and the Wilcoxon Matched-Pairs Signed-Ranks test. The results of both tests are reported in Panel A of table 6.7. The t-value and Z value are positive and statistically significant at the 0.01 level in both the RD and RDR models suggesting that capitalizing firms are expected to spend less under the expensing method than they actually do under the capitalization method. These results confirm the result obtained earlier by the t-test on $\hat{\sigma}_{1\epsilon}$.

To examine the robustness of the above results, the analysis described above is repeated using the expense group. The question here is "What would have been the reaction of expensing firms toward R&D spending if SFAS No. 2 had eliminated the expense method instead?" To answer this question, equation 8.2 in Chapter V is estimated and the residual is examined using both the t-test and the Wilcoxon Matched-Pairs Signed-Ranks test. The results of both tests are reported in table 6.8 (Panel B). Consistent with the result obtained earlier by the t-test on $\hat{\sigma}_{2\epsilon}$, the t-value and Z-value are not significantly different from zero.

The major finding that emerges from the previous analysis is that the <u>ex-ante</u> analysis predicts significant potential reduction in capitalizers' R&D expenditures in response to SFAS No. 2. Thus, the null hypothesis of no significant effect of eliminating the capitalization method on capitalizers' R&D spending is rejected at conventional levels.

Finally, a comparison of the regression estimates of the RD and RDR models indicates that the estimated coefficients of both models in the two samples are qualitatively similar across all independent variables (except for the cash flow variable in the capitaling group

and the concentration variable in both groups). This suggests that controlling for intraindustry differences using two-digit SIC codes has virtually no impact on the results. Three possible interpretations of this finding are: (1) it is possible that firms' reaction to SFAS No. 2 is not significantly different from one industry to another, (2) it is possible that the industry concentration variable captured industry-specific effects, or (3) using the two-digit industry code may be a poor proxy for industry-specific effects.

6.2.2 Results of Ex-post Analysis

The _ex-ante_ test results suggest that capitalizing firms are expected to significantly reduce their R&D spending if forced to switch to the expense method. The purpose of the _ex-post_ analysis is to examine whether capitalizers actually reduced their R&D spending in response to the implementation of SFAS No. 2. This objective is achieved by testing for structural changes in the R&D model after 1974 using the F test. The occurrence of a structural change from the pre-SFAS No. 2 to the post-SFAS No. 2 periods would be manifest in the regression slopes, intercepts, or both. The results of the F test are presented in Table 6.9 (Panel A).

The F-values resulting from the testing for differential regressions are statistically significant at conventional levels over the period 1975-1977 for RD model while the years 1975 and 1976 are significant for the RDR model. The F-values resulting from the testing for differential intercepts, however, are not significantly different from zero for all years in both RD and RDR models. These results suggest that any change between the two periods must lie in the regression slopes rather than in the intercepts. The result of

testing for differential slopes shows highly significant F-values during the years 1975-1977 for the RD model. However, when intraindustry differences are accounted for, only 1975 and 1976 show significant differential slopes.

Thus, both the null hypothesis of no structural change in the R&D model after the implementation of SFAS No. 2 is rejected at the 0.01 level for both differential regressions and slopes for the years 1975 and 1976. The results, however, do not provide any evidence to reject the null hypothesis of no structural change in the intercepts. This finding can be explained on the grounds that the fixed cost component in R&D activities is typically a long term committed cost which is less sensitive (at least in the short run) to management's manipulation.

It can be argued that statistically significant results might have been obtained because of a trend or economy wide change rather than the accounting change. To examine for this possiblity , the three tests for structural changes are conducted on the expense sample. The results are reported in Panel B of table 6.8.

The F-values resulting from the three tests for both RD and RDR models during the period 1975-1977 are statistically insignificant (except 1978 which shows significant differential regressions and slopes for both models, and 1977 which shows significant differential regressions and slopes for the RDR model). These results suggest that the significant differential regression and slopes in the capitalizers' R&D function during 1975 and 1976 can be attributed to the implementation of SFAS No. 2 rather than to economy wide changes.

In order to determine the direction of the change in the R&D function after 1974, equations 11 and 12 in Chapter V are estimated for both capitalizing and expensing firms for years 1973, 1975, and

1976. The results (see Table 6.9) indicate that the estimated values of R&D for capitalizing firms are lower in 1975 and 1976 than they were in 1973. For expensing firms, however, the estimated values of R&D in 1975 and 1976 are virtually the same as they were in 1973. These results suggest a net negative effect on R&D associsted with the structural change in capitalizers' R&D fuction in 1975 and 1976. These results confirm the results obtained from the <u>ex-ante</u> analysis and the F tests.

To summarize, the statistical results obtained from both the <u>ex-ante</u> and <u>ex-post</u> analyses provide strong evidence suggesting a significant association between the implementation of SFAS No. 2 and the observed reduction in R&D spending by capitalizing firms after 1974. In the <u>ex-ante</u> analysis, the two-stage switching regression model predicted a significant potential reduction in R&D spending if capitalizing firms were forced to switch to the expense method. This finding is confirmed by the results obtained from the <u>ex-post</u> analysis. A significant change in the structure of the R&D function for capitalizing firms was detected, particularly in 1975 and 1976. Furthermore, the results indicate that the change in the R&D model lies in the regression slopes rather than in the intercepts.

The main conclusion that emerges from the above results is that SFAS No. 2 had a negative impact on previous capitalizers' R&D investments for at least two years after the accounting change became mandatory. This negative reaction to the accounting change, however, did not last beyond 1977. Consistent results across both <u>ex-ante</u> and <u>ex-post</u> analyses indicate that the swiching regression analysis is an appropriate research methodology for examining, a priori, potential economic consequences of proposed accounting changes before they are even promulgated. This line of research could, therefore, provide

policy makers with valuable information that might guide and improve the standard setting process.

6.3 Results of Testing the Impact of ERTA on Firms' R&D Expenditures

The second research question addressed in this study is to examine whether managers' R&D investment decisions have been influenced favorably by the 1981 tax incentives. The sample used to investigate this question consists of 260 firms spanning the period 1978-1984.[5] Two distinct periods are covered: pre-ERTA (1978-1980) and post-ERTA (1982-1984). The 1981 transition period is excluded from the analysis.

The effectiveness of ERTA tax incentives in stimulating firms' R&D investments is examined by testing for structural change in the R&D model. This test begins with estimation of the R&D model using OLS on the data available during the pre-ERTA period. Since each sample firm has three years of observations prior to 1981, one can obtain more efficient parameter estimates by pooling the data over time and cross-sectionally. This technique assumes that the model is stable over time (Pindyck and Rubinfeld, 1981, pp. 252-253).

To examine for the stability of the model over the pooling period (1978-1980), the R&D model is first estimated for each individual year. Then, the F test is conducted to examine whether the intercepts and slopes are constant over the pooling period. The same procedure is repeated for 1982-1984 to examine the possibility of pooling the data over time and cross-sectionally during the post-ERTA period.

Table 6.10 presents the results of the F test for the null hypothesis of homogeneous intercepts and slopes of the R&D model during each of the two pooling periods. The results show that none of the F values during either the pre-ERTA or post-ERTA periods are

statistically significant at acceptable levels of significance for both the RD and RDR models. These results indicate that the economic behavior of the R&D model is stable during each of the two pooling periods. This provides strong justification for pooling the data cross-sectionally and intertemporally during each period.

Table 6.11 presents the estimated coefficients of both models for each individual year as well as for the pooled data. Panel A presents the estimates from fitting the RD model whereas Panel B presents the corresponding results from the RDR model. A discussion of the regression results obtained from using the pooled data during the period 1978-1980 is presented below, followed by a discussion of the results of testing for structural change in the R&D model.

The estimated coefficient on the size variable is consistently positive and statistically significant at the 0.01 level for all years in both the RD and RDR models. These results are consistent with those obtained earlier in examining the impact of SFAS No. 2. With respect to the behavior of R&D as firm size increases, the coefficient on the size square term is positive and statistically significant at the 0.01 level during both the pre-ERTA and post-ERTA periods for the R&D model. However, after controlling for industry effects, the estimated coefficient of the size square term is positive during the pre-ERTA period and negative during the post-ERTA period. Both results are statistically significant at the 0.01 level. These findings suggest that, in the pre-ERTA period, large firms spend relatively more on R&D while small firms spend relatively more on R&D during the post-ERTA period.

The estimated coefficient on the cash flow variable is, as expected, positive and statistically significant at the 0.01 level for both models in both periods. This result suggests that the availability of internally generated funds heavily influences R&D investment decisions. This finding is also consistent with those obtained from estimating the R&D model for testing the impact of SFAS No. 2.

The estimated coefficient on the capital investment variable is, as expected, negative and statistically significant at the 0.01 level during both periods for the RD model. After controlling for industry effects, however, the cash flow variable shows negative but insignificant results during the pre-ERTA period and highly significant negative results during the post-ERTA period. These results suggest that capital investment is competing with R&D for firms' limited budgets and that this competition becomes stronger during the post-ERTA period. This might be attributed to the tax incentives provided by ERTA to stimulate firms to increase capital investments.

The diversification variable exhibits quite different behavior during the two periods. While the estimated coefficient of diversification during the pre-ERTA period is positive, it is negative in both models during the post-ERTA period. Both results are statistically significant at the 0.01 level. These results indicate that highly diversified firms used to spend relatively more on R&D , but that the opposite relationship exists after 1981. One possible interpretation is that less diversified firms were motivated more by the tax incentives provided by ERTA than were highly diversified firms.

Contrary to the prior expectation of a positive association between the level of industrial concentration and R&D spending, the estimated coefficient on the concentration variable is consistently negative and statistically significant at the 0.01 level for both models during both periods. These results strongly suggest that firms in highly concentrated industries spend less on R&D than do firms in less concentrated industries. This finding does not provide support for the Schempeterian hypothesis.

Having estimated the R&D model for the pre and post-ERTA periods, the next step involves testing for structural changes in the R&D model after the enactment of ERTA in 1981. As explained in Chapter V, the occurrence of a structural change from the pre-ERTA period to the post-ERTA period would be manifest in the regression parameters. The F test is conducted to examine for possible shift or change in the R&D model by contrasting the pooled R&D regression cofficients for the pre-ERTA period with their corresponding coefficients for each year after 1981 and for the pooled data in the post-ERTA period.

Table 6.12 presents the F-statistics resulting from testing for differential regressions, differential slopes, and differential intercepts. The results clearly indicate that the structure of the overall model after 1981 is significantly different than before 1981. This finding is significant at the 0.01 level for each individual year and for the pooled data in both the RD and RDR models. The F statistics for testing differential slopes and for differential intercepts are also statistically significant at the 0.01 level for all years and for both models. Thus, the null hypothesis of no structural

changes in the R&D model after the enactment of ERTA is rejected at the 0.01 level.

As discussed in Chapter V, the F test examines the joint effects of all parameters on the depenent variable. Hence, the above results do not indicate the direction of the change pertaining to R&D expenditures after 1981. Examining the regression results reported in Table 6.12 indicate that the intercept has shifted up for all years after 1981. This suggests a positive influence of the tax incentives on the fixed component of R&D investment.

To determine whether the net effect of the structural change in the R&D model as a whole (i.e., both the intercept and slopes) on R&D expenditures, the expected value of R&D for the pre-ERTA period (using the estimated coeffecents resulted from fitting equation 13, in Chapter V, on the pooled data) is evaulated at the mean values of the independent variables during the period 1978-1980. Similarly, the expected value of R&D expenditures for the post-ERTA period (using the estimated coefficients resulting from fitting equation 14, in Chapter V) is evaluated at the mean values of the independent variables during the period 1978-1980. The results of these estimations are reported in Table 6.13. A comparison of the estimated values of R&D for the pre-ERTA period with those of the post-ERTA period indicate that the estimated values of R&D expenditures for all years after 1981 are indeed higher than before 1981. These results suggest that the tax incentives provided by ERTA has positively influenced R&D investment. This finding leads to a rejection of the null hypothesis of no significant impact of the tax incentives provided by ERTA on firms' R&D investments.

Table 6.1

Operational Definitions of Variables Included in the R&D Model

Variable	Predicted Sign	Definition [a]
Panel A: R&D model using the absolute dollar amounts (RD Model).		
RD	Dependent Variable	Research and development expenditures incurred by each firm in the sample.
TA	+	Total assets for each firm in the sample.
TASQR	?	Total assets squared for each firm in the sample.
CAP	-	Capital expenditures incurred by each firm in the sample.
CF	+	Cash flow available for each firm lagged one period.
DIV	+	An index of product diversification measured by the number of four-digit SIC industries in which the firm operates.
CONC8	+	Concentration ratio of sales at the eight-firm level of three-digit SIC code.
Panel B: R&D model scaled by the average industry[b] (RDR Model).		
RDR	Dependent Variable	Research and development expenditures incurred by each firm in the sample scaled by the average R&D expenditures in the industry.
TAR	+	Total assets for each firm in the sample scaled by the average total assets in the industry.
TARSQR	?	The square of total assets for each firm in the sample scaled by the average total assets in the industry.
CAPR	-	Capital expenditures incurred by each firm in the sample scaled by the average capital expenditures incurred by the industry.
CFR	+	Cash flow available for each firm scaled by the average industry cash flow.
DIV	+	As defined in Panel A.
CONC8	+	As defined in Panel A.

a. The financial variables are converted to constant dollars using the implicit price deflators for GNP (1982 = 100).

b. The industry averages are computed for all companies available on the Compustat tapes using two-digit SIC codes.

Table 6.2

Operational Definitions of Variables
Included in the Accounting Choice Model

Variable	Predicted Sign	Definition[a]
AC	Dependent Variable	The accounting method chosen by each firm in the sample to report R&D expenditures prior to 1974 defined as AC=1 if the ith firm is a capitalizer and zero otherwise.
LEV	+	The leverage ratio for each firm computed by dividing the book value of long term debts by the market value of the equity plus the book value of the long term debts.
LNTA	–	The natural logarithm of total assets for each firm in the sample.
RDVAR	+	An index of the volatility of R&D expenditures.
NIVAR	+	An index of the volatility of reported earnings.
RDM	+	An index of the materiality of R&D expenditures for each firm in the sample.

a. The financial variables are converted to constant dollars using the implicit price deflators for GNP (1982 = 100).

Table 6.3

Results of Testing Whether
Capitalizing Firms and Expensing Firms
Have Significant Differential R&D Function
(Capitalizers: N = 121, Expensers: N =227)

	RD Model		RDR Model	
	F-Value	Significance Level	F-Value	Significance Level
Differential regressions (slopes and intercepts)	15.375	$P < 0.001$	29.748	$P < 0.001$
Differential slopes	16.961	$P < 0.001$	33.974	$P < 0.001$
Differential intercepts	10.30	$P < 0.001$	3.316	$P < 0.060$

Table 6.4

Results of Probit Estimates
of the Accounting Choice Model
(N=367)

Dependent Variable:	AC[a]	
Observations	367	Cases Correct 331
Log Likelihood	-70.28	Average Likelihood .825

Variable	Coefficient	Standard Error	T-Statistic
Intercept	-0.4594	0.4450	-1.0323
LEV	3.6707	0.5667	6.4766***
LNTA	-0.8466	0.1362	-6.2131***
RDVAR	0.0579	0.0090	6.4231***
NIVAR	0.5523E-05	0.1730E-05	3.1908***
RDM	6.2876	3.1536	1.9938**

a AC = 1 if the ith firm is a capitalizer and zero otherwise.
* Significant at the 10% level of significance.
** Significant at the 5% level of significance.
*** Significant at the 1% level of significance.

Table 6.5

Comparison of the Regression Results from Estimating the RD and RDR Models for the Capitalizing Sample Before and After Correcting for Self Selection Bias (using 1973 Data) (N = 121)

Panel A: Estimates from R&D Model using absolute dollar amounts.

Variable	Before Correcting for Self-Selection		After Correcting for Self-Selection	
	Coefficient	T-Statistic	Coefficient	T-Statistic
INTERCEPT	2.8250	3.242***	3.3478	3.800***
TA	0.0129	3.857***	0.0146	4.332***
TASQR	-0.027E-4	-3.614***	-0.023E-4	-2.977***
CF	0.0308	0.922	0.02379	0.724
CAP	-0.0378	-2.700***	-0.0415	-3.009***
DIV	-0.4933	-2.391***	-0.4961	-2.281***
CONC8	-1.8140	-1.342	-2.4239	-1.765**
ACM_C	---	---	-1.4024	-2.368***
Adj. R^2	90.08		91.25	

Panel B: Estimates from R&D Model scaled by average industry.

Variable	Before Correcting for Self-Selection		After Correcting for Self-Selection	
	Coefficient	T-Statistic	Coefficient	T-Statistic
INTERCEPT	0.1707	1.236	0.26885	1.958**
TAR	1.0645	5.944***	1.0965	6.319***
TARSQR	-0.2294	-4.073***	-0.2231	-4.099***
CFR	0.6972	3.141***	0.7196	3.355***
CAPR	-0.5310	-4.415***	-0.5490	-4.715***
DIV	-0.0754	-2.413***	-0.0621	-2.033***
CONC8	-0.0490	-0.233	-0.1561	-0.755
ACM_C	---	---	-0.2567	-2.871***
Adj. R^2	40.78		44.64	

* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

Table 6.6

Comparison of the Regression Results from Estimating
the RD and RDR Models for Expensing Sample
Before and After Correcting for Self-Selection Bias (using 1973 Data)
(N = 227)

Panel A: Estimates from R&D Model using absolute dollar amounts.

Variable	Before Correcting for Self-Selection		After Correcting for Self-Selection	
	Coefficient	T-Statistic	Coefficient	T-Statistic
INTERCEPT	9.1041	1.821*	8.1743	1.639*
TA	0.0322	7.830***	0.0330	7.960***
TASQR	0.054E-4	11.072***	0.055E-4	11.447***
CF	0.2326	7.288***	0.2348	7.366***
CAP	-0.1855	-6.255***	-0.1851	-6.328***
DIV	-2.3978	-3.052***	-2.4275	-3.092***
CONC8	-15.5712	-1.737*	-16.0909	-1.798*
ACM_E	---	---	4.4765	1.374
Adj. R^2	76.34		76.47	

Panel B: Estimates from R&D Model scaled by average industry

ariable	Before Correcting for Self-Selection		After Correcting for Self-Selection	
	Coefficient	T-Statistic	Coefficient	T-Statistic
INTERCEPT	0.1596	0.931	0.1372	0.903
TAR	0.2264	2.696***	0.2319	2.737***
TARSQR	0.0257	2.662***	0.0242	2.455***
CFR	0.8777	7.984***	0.8871	7.987***
CAPR	-0.1851	-3.635***	-0.1866	-3.683***
DIV	-0.0581	-2.153***	-0.0581	-2.150**
CONC8	-0.1290	-0.427	-0.1286	-0.424
ACM_E	---	---	0.0758	0.664
Adj. R^2	93.65		93.63	

*   Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level.

Table 6.7

Results of Estimating Potential Changes
in R&D Spending for Capitalizers and Expensers
if Each Group was Forced to Switch to the Other Alternative in 1973[a]

	T-test		Wilcoxon Signed-Rank Test	
	t-statistic	Significance Level	Z-statistic	Significance Level
Panel A: Capitalizing Firms				
RD Model	8.11	$P < 0.01$	6.45	$P < 0.01$
RDR Model	2.30	$P < 0.01$	6.39	$P < 0.01$
Panel B: Expensing Firms				
RD Model	1.39	$P < 0.18$	1.14	$P < 0.25$
RDR Model	1.33	$P < 0.19$	1.53	$P < 0.12$

[a] The unexpected change in the R&D expenditures is defined as the actual R&D expenditures in 1973 minus the amount of R&D that a firm is expected to spend in 1973 under the other alternative method.

Table 6.8

Results of Testing for Structural Change
in the R&D Model of Capitalizing and Expensing Firms
After the Implementation of SFAS #2

	Differential regressions		Differential slopes		Differential intercepts	
	F-Value	Significance Level	F-Value	Significance Level	F-Value	Significance Level
Panel A: Capitilizing Firms						
RD Model						
1975	23.59	P < 0.001	27.306	P < 0.001	0.771	P < 0.381
1976	11.07	P < 0.001	12.910	P < 0.001	0.042	P < 0.837
1977	3.57	P < 0.001	4.156	P < 0.001	0.361	P < 0.545
1978	1.56	P < 0.141	1.806	P < 0.100	0.099	P < 0.750
RDR Model						
1975	2.13	P < 0.040	2.466	P < 0.020	0.1601	P < 0.689
1976	3.53	P < 0.030	4.094	P < 0.010	0.141	P < 0.706
1977	1.40	P < 0.196	1.793	P < 0.089	0.789	P < 0.375
1978	1.21	P < 0.297	1.293	P < 0.264	0.486	P < 0.758
panel B: Expensing Firms						
RD Model						
1975	1.65	P < 0.150	1.760	P < 0.110	0.078	P < 0.770
1976	0.83	P < 0.540	0.945	P < 0.440	0.000	P < 0.990
1977	0.65	P < 0.680	0.760	P < 0.570	0.081	P < 0.770
1978	2.66	P < 0.010	3.160	P < 0.001	0.117	P < 0.740
RDR Model						
1975	1.03	P < 0.270	1.34	P < 0.190	0.173	P < 0.670
1976	1.47	P < 0.160	1.590	P < 0.130	0.110	P < 0.730
1977	3.74	P < 0.001	4.043	P < 0.001	0.136	P < 0.710
1978	6.60	P < 0.001	7.140	P < 0.001	0.019	P < 0.900

Table 6.9

Estimated R&D Expenditures
Evaluated at the Mean Values
of the Independent Variables in 1973

	RD model	RDR Model
Capitalizing Firms		
1973	$7.03	0.288
1975	1.63	0.184
1976	3.54	0.134
Expensing Firms		
1973	15.43	0.716
1975	15.23	0.866
1976	15.82	0.689

TABLE 6.10

Results of The F Test to Determine Whether Data Can Be Pooled Cross-Sectionally and Intertemporally for Periods 1978-1980 and 1982-1984

	Differential Regressions		Differential Slopes		Differential Intercepts	
	F-Value	Significance Level	F-Value	Significance Level	F-Value	Significance Level
Panel A:						
Pre-ERTA RD Model 1978-1980	1.365	$P < 0.16$	1.52	$P < 0.11$	0.36	$P < 0.67$
RDR Model 1978-1980	0.66	$P < 0.71$	0.89	$P < 0.74$	0.15	$P < 0.76$
Panel B:						
Post-ERTA RD Model 1982-1984	1.390	$P < 0.21$	1.33	$P < 0.33$	0.31	$P < 0.57$
RDR Model 1982-1984	1.02	$P < 0.41$	1.19	$P < 0.31$	0.01	$P < 0.93$

TABLE 6.11

OLS Estimation Results of the R&D Model
For the period 1978 - 1984

Panel A: Estimates from R&D model using absolute dollar amounts (RD Model)

Year	N	Estimated Coefficients[a]							Adj. R^2
		Intercept	TA	TASQR	CF	CAP	Div	Conc 8	
1978	251	2.787	0.009	0.22E-5	0.128	-0.154	1.617	-9.960	0.69
		(0.79)	(3.01)***	(4.73)***	(6.54)***	(-6.82)***	(2.86)***	(-1.91)**	
1979	243	3.710	0.008	0.34E-5	0.095	-0.134	3.22	-14.74	0.67
		(0.96)	(2.23)**	(6.47)***	(4.14)***	(-5.74)***	(4.90)***	(-2.42)***	
1980	241	3.430	0.014	0.20E-5	0.113	-0.157	2.89	-14.47	0.67
		(0.76)	(3.99)***	(3.76)***	(5.32)***	(-7.14)***	(4.06)***	(-2.04)**	
pooled	731	3.510	0.011	0.25E-5	0.109	-0.145	2.50	-13.36	0.67
(1978-1980)		(1.54)	(5.49)***	(8.51)***	(8.93)***	(-11.28)***	(6.71)***	(-3.76)***	
1982	233	11.780	0.026	0.16E-5	0.126	-0.207	-0.890	-17.480	0.65
		(2.60)***	(5.63)***	(1.09)	(5.99)***	(-7.37)***	(-1.26)	(-2.30)**	
1983	233	8.99	0.022	0.59E-5	0.113	-0.267	-1.480	-7.940	0.67
		(1.98)**	(4.63)***	(3.74)***	(7.13)***	(-7.93)***	(-1.84)*	(-0.99)	
1984	223	8.65	0.013	0.05E-5	0.196	-0.105	-0.651	-13.376	0.68
		(1.63)*	(2.32)**	(0.47)	(10.30)***	(-2.64)***	(-0.75)	(-1.53)	
pooled	691	9.480	0.022	0.27E-5	0.134	-0.209	-1.083	-11.80	0.66
(1982-1984)		(3.35)***	(7.77)***	(2.93)***	(13.04)***	(-11.00)***	(-2.35)**	(-2.50)***	

TABLE 6.11 (continue)

Panel B: Estimates from R&D model scaled by industry average (RDR Model)

Year	N	Estimated Coefficients							Adj. R^2
		Intercept	TAR	TASQR	CFR	CAPR	Div	Conc 8	
1978	251	0.168	0.195	0.032	0.312	-0.111	0.046	-0.304	
		(0.88)	(2.07)**	(5.23)***	(3.67)***	(-1.68)*	(1.56)	-(1.08)	0.73
1979	243	0.239	0.437	0.021	0.109	-0.188	0.063	-0.552	
		(1.10)***	(3.41)	(3.53)***	(0.93)	(-3.16)***	(1.69)*	(-1.63)*	0.67
1980	241	0.227	0.428	0.009	0.201	-0.069	0.046	-0.477	
		(1.02)	(4.01)***	(1.54)	(1.86)*	(-1.04)	(1.33)	(-1.35)	0.66
pooled	731	0.208	0.326	0.019	0.128	-0.046	0.054	-0.455	
(1978-1980)		(1.70)*	(5.12)***	(5.68)***	(2.19)**	(-1.29)	(2.73)***	(-2.41)***	0.68
1982	233	0.602	0.895	-0.057	0.268	-0.216	-0.071	-0.956	
		(3.08)***	(7.99)***	(-4.79)***	(3.76)***	(-2.98)***	(-2.46)***	(-2.86)***	0.56
1983	233	0.567	0.761	-0.006	0.261	-0.214	-0.070	-0.833	
		(3.38)***	(7.37)***	(-0.93)	(4.69)***	(-3.64)***	(-2.73)***	(-2.92)***	0.63
1984	223	0.313	0.363	0.009	0.527	-0.180	-0.043	-0.404	
		(2.20)**	(2.66)***	(0.27)	(7.74)***	(-3.53)***	(-2.07)**	(-1.69)*	0.64
pooled	691	0.486	0.817	-0.039	0.214	-0.155	-0.062	-0.739	
(1982-1984)		(4.88)***	(13.65)***	(-4.88)***	(6.86)***	(-4.50)***	(-4.18)***	(-4.37)***	0.59

a. The figures in parentheses are t-statistics.

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

Table 6.12

Results of Testing for Structural Changes in the R&D Model After the Introduction of ERTA of 1981

	Differential Regressions		Differential Slopes		Differential Intercepts	
	F-Value	Significance Level	F-Value	Significance Level	F-Value	Significance Level
RD Model						
1982	5.45	P < 0.001	5.52	P < 0.001	4.85	P < 0.02
1983	8.03	P < 0.001	8.68	P < 0.001	3.04	P < 0.04
1984	7.00	P < 0.001	7.17	P < 0.001	5.75	P < 0.01
RDR Model						
1982	5.76	P < 0.001	6.71	P < 0.001	2.32	P < 0.12
1983	3.32	P < 0.001	3.87	P < 0.001	3.09	P < 0.04
1984	2.48	P < 0.010	2.88	P < 0.001	4.35	P < 0.01

Table 6.13

Estimated R&D Expenditures
Evaluated at the Mean Values
of the Independent Variables during 1978-1980

	RD model	RDR Model
1978-1980	$17.98	0.413
1982	20.88	0.547
1983	23.00	0.565
1984	20.71	0.614

6.4 Notes

1. The industry averages are computed for all firms on the COMPUSTAT tapes using the two-digit SIC (Standard Industrial Classification) system.

2. An alternative and slightly finer measure of diversification is to weight this index by the percentage of the firm's sales in each industry (for more details, see Montgomery, 1985). This alternative measure, however, was not used in this study because of data availability problems.

3. This index can be constructed by measuring alternatively the four, eight, twenty, or fifty concentration ratios. The four and eight company concentration ratios are the most widely used. In the preliminary analysis, both the four and eight measures were considered and produced similar results.

4. The accounting choice model was also estimated using Logit analysis. The results obtained from the Logit estimation procedure are qualitatively similar to those reported in Table 6.4.

5. The years before 1978 were excluded from the analysis because of possible confounding results from SFAS No. 2.

Chapter VII

SUMMARY AND CONCLUSIONS

The objective of this study is to examine empirically the impact of two important events on firms' incentives to invest in research and development activities: (1) the issuance of the Statement of Financial Accounting Standards No. 2 in 1974, which has prompted much debate regarding its potential negative impact on firms' R&D activities, and (2) the enactment of the Economic Recovery Tax Act in 1981, which contained provisions designed to stimulate firms' R&D activities.

The impact of SFAS No. 2 was examined both ex-ante using the two-stage switching regression analysis and ex-post using tests for structural changes. The impact of ERTA was examined using tests for structural changes. Employing these research methods required the development of a model explaining the economic determinants of R&D investments (R&D model). In addition, the two-stage switching regression methodology required the development of a second model explaining the managerial choice of accounting method for reporting R&D costs (AC model).

In order to minimize the effect of changes in macroeconomic conditions (particularly inflation) on the results, the financial variables in both the R&D and AC models were converted to constant dollars using the Implicit Price Deflator for GNP (1982 = 100). To control for industry-specific effects, each variable in the R&D model was scaled by its corresponding industry average using the two-digit SIC code. The two research problems addressed in this study,

therefore,were examined using both the absolute dollar amounts model (RD model) and the R&D model scaled by industry average (RDR model).

The regression results of estimating the R&D model indicate that the model is well specified. This finding is evidenced by a significantly high R^2 coupled with highly significant coefficients on the independent variables. Firm size, cash flow, and capital investment variables are all highly significant and directionally consistent with prior expectations suggesting that they are important factors in explaining R&D investments. Though the results strongly suggest a non-linear relationship between increases in firm size and R&D expenditures, the direction of the sign is not consistent throughout the analysis which makes conclusions about the Schumpeterian hypothesis difficult. The product diversification and industry concentration variables are often directionally opposed to prior expectation and usually lack statistical significance, rendering the findings inconclusive. Finally, since the estimated coefficients are qualitatively similar in both the RD and RDR models, very little has been gained by controlling for industry-specific effects. This finding indicates that either the industry-specific effect has been captured by the industry concentration variable or that controlling for two-digit industry effects is not an appropriate proxy for controlling for industry-specific effects.

Estimating the accounting choice model by probit analysis clearly indicates that the model possesses good overall explanatory power and high classificatory ability (90% of all firms are classified correctly). The estimated coefficients of all variables are statistically significant and directionally consistent with prior expectations. The results strongly suggest that leverage, firm size,

volatility of R&D expenditures, volatility of reporting earnings, and materiality of R&D expenditures are all significant factors in explaining the managerial choice of accounting method for reporting R&D expenditures. The main results obtained from examining the two research questions are summarized below.

7.1 Discussion of the Results of Examining the Impact of SFAS No. 2

The *ex-ante* analysis investigates whether and to what extent a mandatory switch to the alternative R&D accounting method is likely to affect R&D spending. This analysis was conducted using the two-stage switching regression methodology. In the first stage, the accounting choice model was estimated on a sample of 367 firms (169 capitalizing and 198 expensing) using maximum likelihood probit analysis. The purpose of this step was to obtain the correction terms $\frac{\phi(\hat{\theta}Zi)}{\Phi(\hat{\theta}Zi)}$ and $\frac{\phi(\hat{\theta}Zi)}{1-\Phi(\hat{\theta}Zi)}$ for each sample observation in the capitalizing and expensing groups, respectively. These two correction terms were then introduced into the R&D equation for each group of firms to correct for self selection bias and to assess the significance of removing the chosen accounting method on R&D spending behavior. The R&D model was then estimated using OLS.

The likely economic consequences of eliminating the capitalization method were assessed by the statistical significance of the t-value of the correction term.

The major finding of the *ex-ante* analysis is that the switching regression model predicted a significant potential reduction in capitalizers' R&D investments in response to SFAS No. 2. This finding

is evidenced by a significant increase in overall explanatory power after including the ACM variable, coupled with a highly significant t-value on the ACM variable. This finding is further supported by highly significant results of both the t-test and Wilcoxon Signed Rank test on the difference between the actual R&D spent in 1973 under the capitalization method and the equivalent amount of R&D that would have been spent by the same firm under the expense method. The results show that capitalizers are expected to spend less under the expense method than they actually do under the capitalization method.

The ex-post analysis was conducted using tests for structural changes. The results of the F test show significant structural changes in the R&D model after the implementation of SFAS No. 2 and that the changes are manifest in the regression slopes rather than in the intercepts.

The major conclusion that emerges from results of both the ex-ante and ex-post analyses is that the implementation of SFAS No. 2 is associated with a significant reduction in R&D expenditures of capitalizing firms for at least two years after the accounting change became mandatory. Evidence from several related tests support the robustness of this finding.

The consistency of significant results in both the ex-ante and ex-post analyses suggests that the switching regression model is an appropriate research methodology for assessing, ex-ante, the likely economic consequences of proposed accounting changes. This line of research could, therefore, provide policy makers with valuable information for improving the standard setting process.

7.2 Discussion of the Results of Examining the Impact of ERTA

The effectiveness of the 1981 ERTA tax incentives in stimulating R&D investment has been assessed using tests for structural changes in the R&D model after 1981. The analysis is conducted in a time-series, cross-sectional framework. The F test was conducted to examine whether the assumption of constant cross-section parameters over the pooling period was satisfied. The results provide no evidence of significant differential intercepts or differential slopes during the 1978-1980 or 1982-1984 periods. These results imply that the pooling would yield more efficient estimates than cross-sectional estimation.

The results obtained from testing for structural changes indicated that the structure of the R&D model after 1981 was significantly different than before and that the changes are reflected in both the intercepts and slopes. Based on the results obtained from this part of the study, the null hypothesis of no significant impact of the ERTA tax incentives to stimulate R&D is rejected at conventional levels.

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BIOGRAPHICAL SKETCH

Mohamed Marghany Shehata was born in Mit-Ghamr, Egypt, on January 23, 1947. In 1968 he received a Bachelor of Commerce from Tanta University, Egypt. In 1975 he received a master's degree in accounting from Ain-Shams University, Egypt. In 1982, he received an M.B.A. from North Texas State University at Denton. He worked as Lecturer for the Department of Accounting at Tanta University, Egypt, from 1968 to 1978. In 1982 he entered the Ph.D. program at the University of Florida. He held a research assistantship and a teaching assistantship in the School of Accounting, University of Florida, while studying for the degree of Ph.D. He is married and the father of one daughter.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

A. R. Abdel-Khalik

A. Rashad Abdel-khalik, Chairman
Graduate Research Professor
of Accounting

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Bipin B. Ajinkya, Cochairman
Professor of Accounting

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Sanford V. Berg

Sanford V. Berg
Associate Professor of Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Robert D. Emerson

Robert D. Emerson
Associate Professor of Food
and Resource Economics

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Antal Majthay

Anatal Majthay
Associate Professor of Management

This dissertation was submitted to the Graduate Faculty of the Fisher School of Accounting in the College of Business Administration and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

August 1988

Madelyn Lockhart
Dean, Graduate School